



Model CFH

ClearFire Packaged Boiler ***Gas High-Efficiency Boiler***

Operation, Service, and Parts Manual



750-222
11/08



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⚠ WARNING

If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

— Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

— WHAT TO DO IF YOU SMELL GAS

- Do not try to light any appliance.
- Do not touch any electrical switch; do not use any phone in your building.
- Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
- If you cannot reach your gas supplier, call the fire department.

— Installation and service must be performed by a qualified Cleaver-Brooks, service agency or the gas supplier.

⚠ WARNING

To minimize the possibility of serious personal injury, fire or damage to the equipment, never violate the following safety rules.

— Always keep the area around the boiler free of combustible materials, gasoline, and other flammable liquids and vapors

— Never cover the boiler, lean anything against it, stand on it, or in any way block the flow of fresh air to the boiler.

Notice

Where required by the authority having jurisdiction, the installation must conform to the Standard for Controls and Safety Devices for Automatically Fired Boilers, ANSI/ASME CSD-1.

⚠ WARNING

Improper installation, adjustment, service, or maintenance can cause equipment damage, personal injury, or death. Refer to the Operation and Maintenance manual provided with the boiler. Installation and service must be performed by a qualified Cleaver-Brooks service provid-

⚠ WARNING

Be sure the fuel supply which the boiler was designed to operate on is the same type as specified on the boiler name plate.

⚠ WARNING

Should overheating occur or the gas supply valve fail to shut off, **do not** turn off or disconnect the electrical supply to the boiler. Instead turn off the gas supply at a location external to the boiler.

⚠ WARNING

Do not use this boiler if any part has been under water. Immediately call your Cleaver-Brooks service representative to inspect the boiler and to replace any part of the control system and any gas control which has been under water.

Notice

This manual must be maintained in legible condition and kept adjacent to the boiler or in a safe place for future reference. Contact your local Cleaver-Brooks representative if additional manuals are required.

 WARNING

The boiler and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of 1/2 psi (3.5 kPa).

 WARNING

The installation must conform to the requirements of the authority having jurisdiction or, in the absence of such requirements, to UL 795 Commercial-Industrial Gas Heating Equipment and/or the National Fuel Gas Code, ANSI Z223.1

Notes

CLEAVER-BROOKS

Model CFH

ClearFire *Packaged Boiler*

Gas High Efficiency Boiler

Operation, Service, and Parts Manual



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Please direct purchase orders for replacement manuals to your local Cleaver-Brooks authorized representative.



DO NOT OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS YOU FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

DO NOT ALLOW OTHERS TO OPERATE, SERVICE, OR REPAIR THIS EQUIPMENT UNLESS THEY FULLY UNDERSTAND ALL APPLICABLE SECTIONS OF THIS MANUAL.

FAILURE TO FOLLOW ALL APPLICABLE WARNINGS AND INSTRUCTIONS MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

TO: Owners, Operators and/or Maintenance Personnel

This operating manual presents information that will help to properly operate and care for the equipment. Study its contents carefully. The unit will provide good service and continued operation if proper operating and maintenance instructions are followed. No attempt should be made to operate the unit until the principles of operation and all of the components are thoroughly understood. Failure to follow all applicable instructions and warnings may result in severe personal injury or death.

It is the responsibility of the owner to train and advise not only his or her personnel, but the contractors' personnel who are servicing, repairing or operating the equipment, in all safety aspects.

Cleaver-Brooks equipment is designed and engineered to give long life and excellent service on the job. The electrical and mechanical devices supplied as part of the unit were chosen because of their known ability to perform; however, proper operating techniques and maintenance procedures must be followed at all times. Although these components afford a high degree of protection and safety, operation of equipment is not to be considered free from all dangers and hazards inherent in handling and firing of fuel.

Any "automatic" features included in the design do not relieve the attendant of any responsibility. Such features merely free him of certain repetitive chores and give him more time to devote to the proper upkeep of equipment.

It is solely the operator's responsibility to properly operate and maintain the equipment. No amount of written instructions can replace intelligent thinking and reasoning and this manual is not intended to relieve the operating personnel of the responsibility for proper operation. On the other hand, a thorough understanding of this manual is required before attempting to operate, maintain, service, or repair this equipment.

Because of state, local, or other applicable codes, there are a variety of electric controls and safety devices which vary considerably from one boiler to another. This manual contains information designed to show how a basic burner operates.

Operating controls will normally function for long periods of time and we have found that some operators become lax in their daily or monthly testing, assuming that normal operation will continue indefinitely. Malfunctions of controls lead to uneconomical operation and damage and, in most cases, these conditions can be traced directly to carelessness and deficiencies in testing and maintenance.

It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly and yearly maintenance activities and recording of any unusual operation will serve as a valuable guide to any necessary investigation. Most instances of major boiler damage are the result of operation with low water. We cannot emphasize too strongly the need for the operator to periodically check his low water controls and to follow good maintenance and testing practices. Cross-connecting piping to low water devices must be internally inspected periodically to guard against any stoppages which could obstruct the free flow of water to the low water devices. Float bowls of these controls must be inspected frequently to check for the presence of foreign substances that would impede float ball movement.

The waterside condition of the pressure vessel is of extreme importance. Waterside surfaces should be inspected frequently to check for the presence of any mud, sludge, scale or corrosion.

It is essential to obtain the services of a qualified water treating company or a water consultant to recommend the proper boiler water treating practices.

The operation of this equipment by the owner and his or her operating personnel must comply with all requirements or regulations of his insurance company and/or other authority having jurisdiction. In the event of any conflict or inconsistency between such requirements and the warnings or instructions contained herein, please contact Cleaver-Brooks before proceeding.

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1.1-MODEL CFH FEATURES AND BENEFITS

Compact Firetube Design

The Model CFH boiler is a compact horizontally fired firetube boiler (Figure 1-1). The extended heating surface tubes provide for very high levels of performance in a compact space. The Model CFH boiler is designed to fire natural gas or LP gas.

High Efficiency

With the extended heating surface provided by the patented AluFer tube design (Figure 1-2) the Model CFH has a nominal fuel to steam efficiency of 85%.

Advanced Construction

Constructed to ASME standards and utilizing AluFer Tube technology in a single-pass design, the Model CFH Boiler will provide many years of trouble free service. Single-pass design provides excellent thermal shock protection.

Ease of Maintenance

The enclosure is readily removable for access to all key burner components. A hinged door on the control panel provides access to all controls.

Quality Construction

ASME construction ensures high quality design, safety, and reliability.

ISO 9001 certified manufacturing process ensures adherence to the highest manufacturing standards.



Figure 1-1 Model CFH Boiler



Figure 1-2 AluFer Tube Cross Section

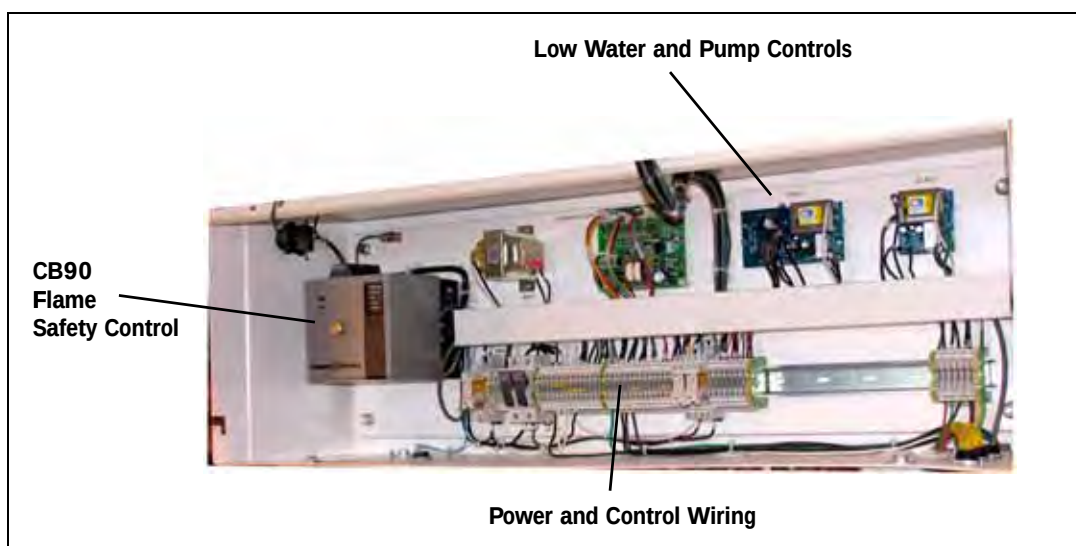


Figure 1-3 Model CFH Electrical Panel

Full Modulation

The burner and combustion fan modulate to provide only the amount of heat required, providing quiet and efficient operation under all conditions.

Premix Technology

The Model CFH Boiler utilizes "Premix" technology to mix both fuel and combustion air prior to entering the firing chamber. This technology provides clean, efficient combustion with very low emission levels.

1.2-THE MODEL CFH BOILER

Firtube boilers are rated in boiler horsepower (BHP), which should not be confused with other horsepower measurements (1 BHP = 33,475 BTU/hr.).

Steam boilers are designed for low pressure or high pressure applications. Low pressure boilers are limited to 15 psig design, and are typically used for heating applications. High pressure boilers are typically used for process loads and can have a design pressure of 75 to 150 psig.

Steam boilers are defined according to design pressure and operating pressure. Design pressure is the maximum pressure used in the design of the boiler for the purpose of calculating the minimum permissible thickness or physical characteristics of the pressure vessel parts of the boiler. Typically, the safety valves are set at or below design pressure. Operating pressure is the pressure of the boiler at which it normally operates. In order to prevent the safety valve from opening too frequently during normal operation, the operating pressure should not exceed 90% of the safety valve setting.

Feedwater equipment should be checked and ready for use. Be sure that all valves, piping, boiler feed pumps, and receivers are installed in accordance with prevailing codes and practices.

As with any firtube boiler, waterside care and maintenance are of critical importance to the Model CFH. Constant attention to water requirements will pay dividends in the form of longer life, less down-time, and prevention of costly repairs.

Care taken in placing the pressure vessel into initial service is vital, as the waterside of new boilers and new or remodeled systems may contain oil, grease or other foreign matter.

The flue side of the Model CFH boiler is virtually maintenance free. Periodic inspection of furnace and Alufer tubes is recommended during required service and inspection intervals. See Chapter 5, Maintenance, for details.



Figure 1-4 Model CFH Boiler

Caution

Waterside care is of prime importance. For specific information or assistance with your water treatment requirements, contact your Cleaver-Brooks service and parts representative. Failure to follow these instructions could result in equipment damage.

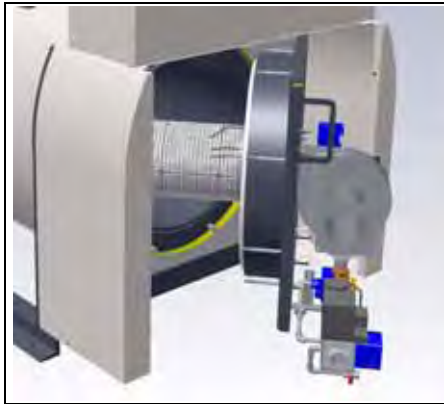


Figure 1-5 Model CFH Burner

1.3-THE BURNER

- A. Incorporating "premix" technology, the burner utilizes a mixing venturi, dual safety shutoff-single body pressure regulating gas valve, variable speed blower, and Fecralloy metal fiber burner canister.
- B. Full modulation is provided using the integral variable speed combustion air fan (up to 5:1 turndown).
- C. Solid body radiation of the burner flame provides clean, efficient combustion and low emissions.
- D. At maximum firing rate, the sound level of the burner is less than 70 dBA, measured in front of the boiler at a distance of 3 feet. At reduced firing rates, sound levels are even lower.
- E. Provision is made for optional direct venting.
- F. Combustion Air Proving Switch standard.
- G. Air filter for combustion air intake standard.

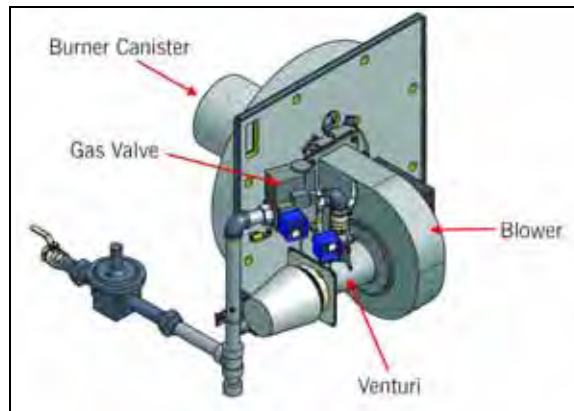


Figure 1-6 Burner Components

1.4-BURNER GAS TRAIN

The gas train assembly is provided in accordance with UL/cUL certification and ASME CSD-1. The gas train assembly is factory assembled and wired, consisting of the following components:

- A. Single body, dual safety shutoff gas valve with integral trim regulator
- B. Low Gas Pressure Switch
- C. High Gas Pressure Switch
- D. (2) Manual Shutoff Valves
- E. Leak Test Cocks
- F. Supply pressure regulator (1 psig max)

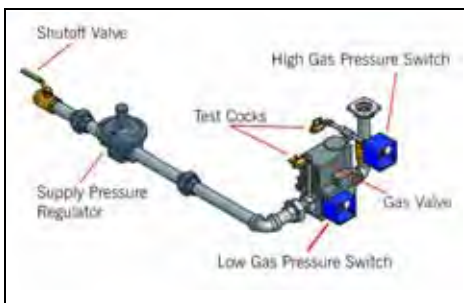


Figure 1-7 Gas Train

1.5-CONTROLS

The Model CFH incorporates the following primary controllers:

- A. The RWF40 modulating pressure controller. PID control drives the variable speed blower for optimum firing rate. Controller display shows Setpoint and Actual Value. Controller can be configured for various options such as dual set point, remote set point, and outdoor reset. Optional Modbus communications version available.
- B. CB90 Flame Safety Control for burner sequencing and flame monitoring. Safe start check, pre-purge, ignition, release to modulation, and post purge steps are controlled by the CB90. Modbus communications available with ED510 display.

Additional control system features include:

- Supervision of low and high gas pressure
- Combustion air proving
- Operating limit control
- High limit control with manual reset
- Low water controls:
 - Primary LWCO/pump control, consisting of control board in the electrical panel and external water column probe
 - Auxiliary LWCO, consisting of control board, manual reset/test switch, and vessel mounted probe
- Safety relief valve

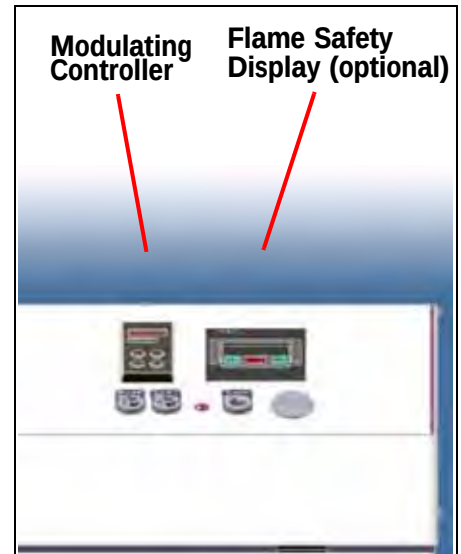


Figure 1-8 Model CFH Controls

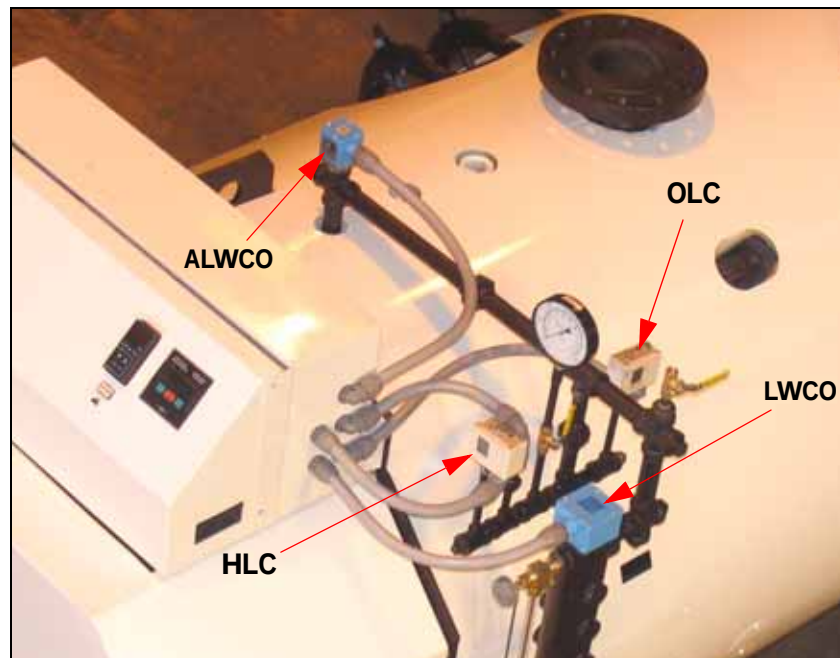


Figure 1-9 Low Water and Limit Controls

1.6-COMPONENT/CONNECTION LOCATIONS

Figure 1-10 shows the Model CFH component orientation.

Refer to Chapter 3 for recommended vent sizes and lengths for the specific boiler installation.

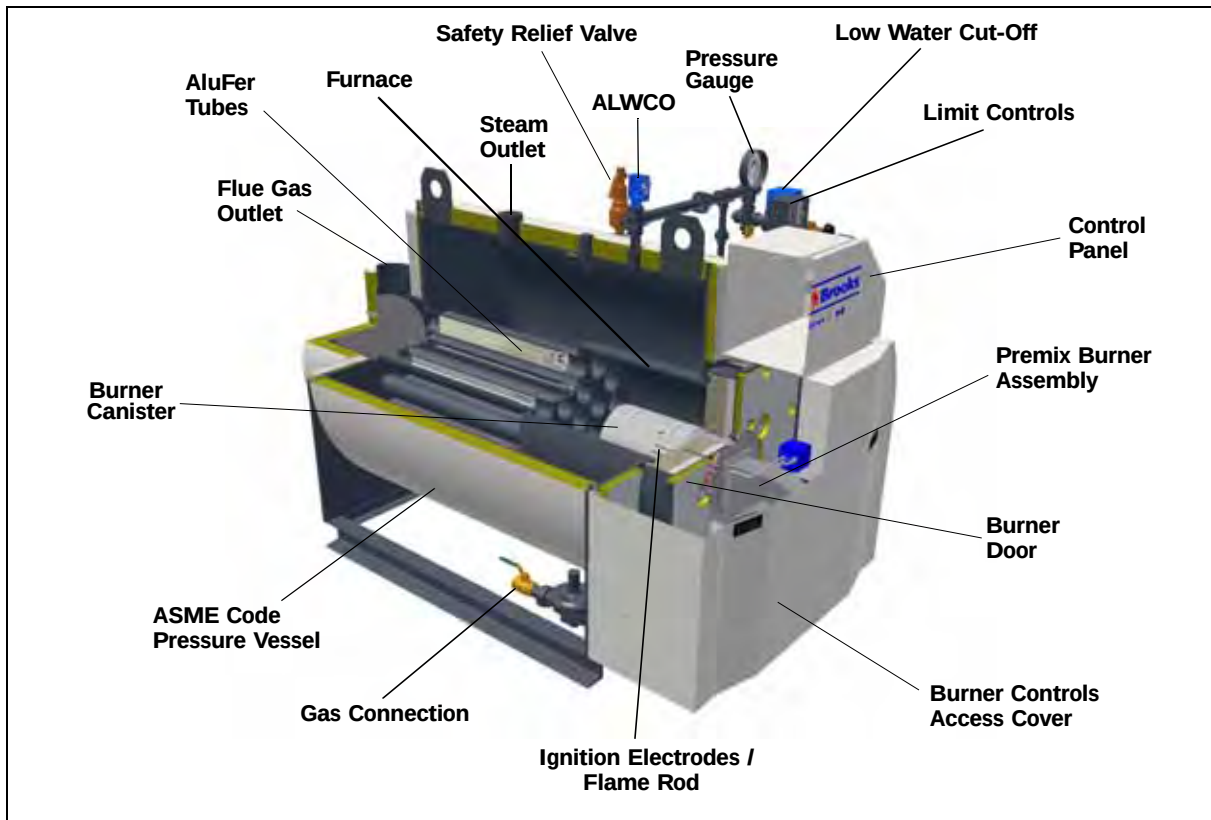


Figure 1-10 Model CFH Steam Boiler

1.7-OPTIONAL EQUIPMENT

Certain options are available for the Model CFH Boiler; normally these will have been specified at the time of order entry. In addition, some options may have been provided (by others) that are not part of Cleaver-Brooks scope of supply. In either case, the Cleaver-Brooks authorized representative should be consulted regarding specific project requirements.

Model CFH optional features (steam boilers)

- Flame Safety Control display on front panel
- Lights & Alarm horn w/ silencing circuit
- Remote modulation/sequencing/boiler status
- Modbus communications (RS-485)
- High Gas Pressure Regulator (> 1 psig supply; shipped loose)
- Gas pressure relief valve (> 1 psig supply; shipped loose)
- Min. Temp./Hot standby
- Sealed combustion/direct vent kit - shipped loose
- Chemical Feed System
- Surface Blow-off
- Integral feedwater system (includes tank, pump, and control) - shipped separately
- Feedwater Valve (on/off)
- Blowdown valves
- Modulating Feedwater Valve & Level Control
- High Water Alarm
- Economizer package (150# steam only)
- Time clock for setback control - shipped loose



Chapter 2 Installation

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Warning

Provisions for combustion and ventilation air must be in accordance with UL 795, Commercial-Industrial Gas Heating Equipment, cUL, or applicable provisions of the local building codes. Failure to follow this warning could result in personal injury or death



Caution

The boiler must be installed such that the gas ignition system components are protected from water (dripping, spraying, rain, etc.) during appliance operation and service. Failure to follow this warning could result in equipment failure.



Warning

If an external electrical source is utilized, the boiler, when installed, must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction or, in the absence of such requirements, with the National Electrical Code and/or UL 795, Commercial-Industrial Gas Heating Equipment.

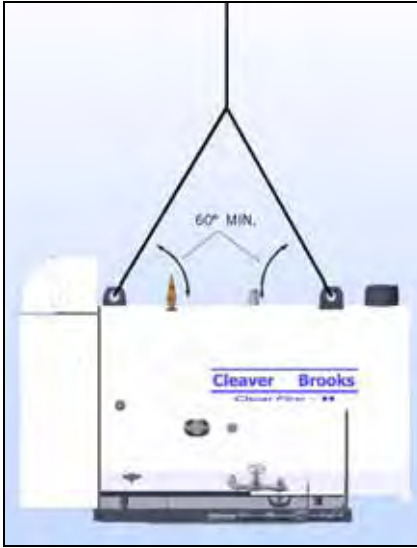


Figure 2-1 Lifting boiler

**Caution**

In order to avoid damage to the unit, lifting or moving the boiler should only be done by experienced personnel suitably equipped for moving heavy equipment.

2.1-Lifting and moving the boiler

The ClearFire-H boiler is equipped with two lifting lugs on top of the boiler shell. These lugs should be used to lift the boiler.

Note: The boiler should not be lifted by the base, or moved by pushing, prying, or pulling on any part of the casing.

The boiler must be installed on a non-combustible floor. If the floor is not level, piers or a raised pad slightly larger in length and width than the boiler base dimensions will make boiler installation and leveling easier.

The boiler must be installed so that all components remain accessible for inspection, cleaning, or maintenance. Field-installed piping and electrical connections must be arranged so as to avoid interfering with removal of the casing panels or with the burner door.

2.2-Water Treatment

Properly treated boiler water will result in maximum effectiveness and long trouble-free life of the pressure vessel. Contact your local Cleaver-Brooks representative or water management consultant for complete information on how to prevent damage resulting from inadequate water treatment.

**Important**

The ClearFire-H boiler requires soft water. Failure to observe this requirement can lead to dangerous operating conditions, and may result in damage to the boiler. If necessary, your Cleaver-Brooks representative can provide additional information regarding your water softening requirements.

The objectives of water treatment in general are to:

1. Prevent hard scale and soft sludge deposits that inhibit heat transfer and that could lead to overheated metal and costly downtime and repairs.
2. Eliminate corrosive gases in the supply or boiler water.

To accomplish these objectives, the boiler requires proper water treatment before and after introduction of water into the unit. The selection of pretreatment processes depends upon the water source, its chemical characteristics, the amount of makeup water needed, system operation practices, etc.

Because of the variables involved, no single boiler compound can be considered a cure-all; nor is it advisable to experiment with homemade treating methods. A sound treatment program should include a periodic analysis of the water in the system.

⚠ Warning *Inadequate or improper water treatment will shorten the life of the boiler, and could result in a hazardous condition.*

The internal or waterside surfaces of the pressure vessel should be inspected at regular intervals for evidence of corrosion, pitting, contamination, or accumulations of foreign matter. If any of these conditions are detected, contact your local Cleaver-Brooks authorized representative for advice on corrective action. It is recommended that a properly sized water meter be installed in the raw water makeup line to accurately determine the amount of raw water admitted to the boiler.

Surface blow-off is available for steam boilers. This option allows removal of surface water impurities through a blowdown line located at the normal operating water level of the boiler. If allowed to accumulate, surface impurities may impede steam release and could cause foaming, leading to priming and carryover in the steam lines.

An optional chemical feed system can be used to introduce controlled amounts of feedwater treatment chemicals into the boiler.

Notice

Corrosion and sludge deposits in old systems must be removed prior to installation of a new boiler.

2.3-Boiler Room

The boiler room must comply with all building codes and regulations. An adequate supply of combustion air and sufficient ventilation are required for safe operation. If the optional direct vent combustion air kit is not used, ventilation must be provided to meet applicable regulations for air supply.

Clean combustion air is required for optimum efficiency and boiler operation (minimum combustion air 10 cfm per boiler horsepower). Dust and airborne contaminants will adversely effect burner performance.

If conditions dictate, a serviceable filter must be placed at the burner inlet to eliminate airborne contamination to the burner.

If a direct vent air intake is used, the intake and flue venting should be terminated so as to prevent rain, snow, dust, or debris from entering the intake piping.

⚠ Warning
The boiler must not be installed on combustible flooring.

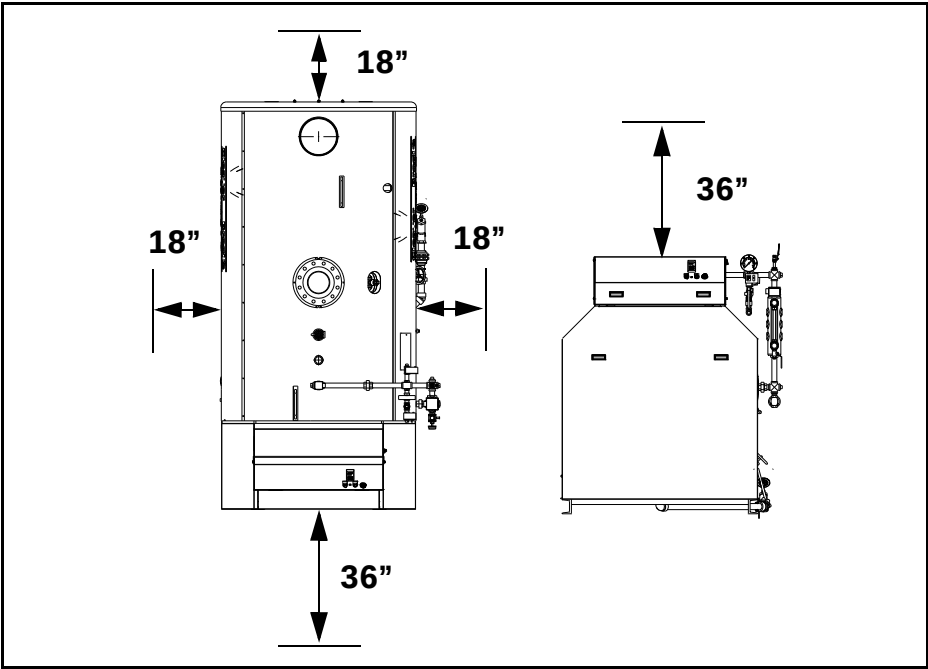


Figure 2-2 Clearances

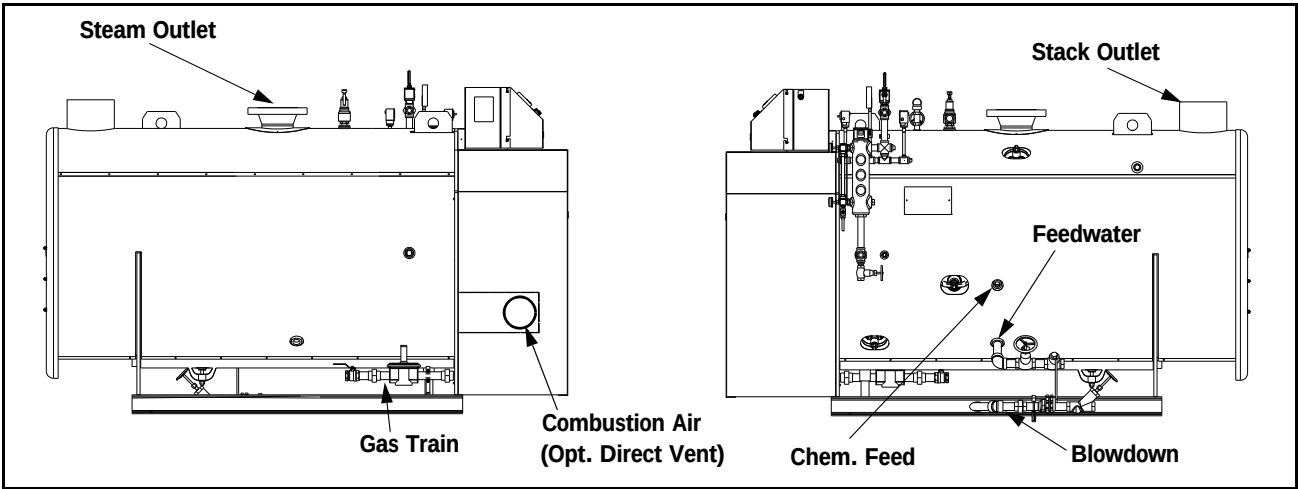


Figure 2-3 CFH Steam Boiler Connections

2.4-Flue Gas Connection

The flue gases from the ClearFire boiler are removed via a gas-tight, temperature and corrosion resistant flue gas pipeline. Only flue gas systems approved and tested by the relevant region or province are to be connected to the ClearFire boiler. Refer to flue piping manufacturer for proper installation and sealing instructions.

See Chapter 3 in this manual for more information.

2.5-Gas Connections

Gas Shut Off Valve and Gas Filter

A manually operated shut-off valve and pressure regulator are provided as standard on the ClearFire-H boiler (**Figure 2-4**). In some cases, local regulations may require the installation of an approved gas filter between the gas shut-off valve and the boiler. Please ask the local gas supply company whether any such regulations apply.

The boiler should be installed so that the gas ignition system components are protected from water (dripping, spraying, etc.) during appliance operation and service.

If building supply gas pressure is greater than 1 psig (27.8" WC), an upstream regulator with overpressure protection and proper gas venting will be required and must be piped to a safe point of discharge. A dedicated gas pressure regulator is required for each boiler to ensure consistent gas pressure at the boiler.

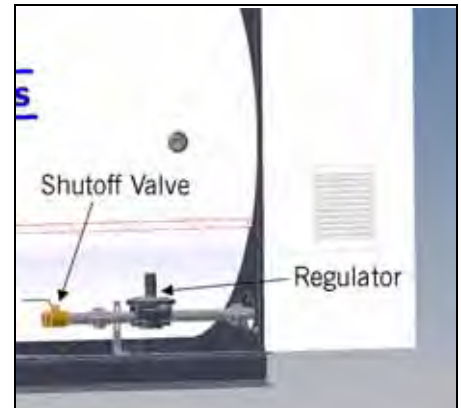


Figure 2-4 ClearFire Gas Piping Shut-off Valve and Regulator



Warning

A sediment trap must be provided upstream of the gas controls.

Notice

Before filling boiler, check that all waterside openings/fittings are plugged and all inspection covers are secured.



Figure 2-5 Feedwater Inlet

2.6-Boiler Water-Side Connections

A pressure relief valve (Safety Valve), provided with the boiler, must be installed in the mounting provided. Use pipe sealing compound and a flat sided wrench when securing the Safety relief valve. Do not use a pipe wrench and do not over tighten the relief valve. The safety valve must be mounted in a vertical position so that discharge piping and code-required drains can be properly piped to prevent buildup of back pressure and accumulation of foreign material around the valve seat area. Apply only a moderate amount of pipe compound to male threads and avoid overtightening, which can distort the seats. Use only flat-jawed wrenches on the flats provided.

Connection to the main steam header is made at the nozzle projecting upward from the boiler shell. ASME code requires a suitable stop valve to be installed between the boiler and main steam header if multiple boilers are tied to the header. This valve should be located as close as possible to the boiler to facilitate venting and pressure testing. A suitably rated gate valve is recommended for this purpose.

Feedwater is introduced through the piping assembly installed on the side of the boiler vessel. A stop valve and check valve are optional equipment (**Figure 2-5**).

The feedwater supply should provide sufficient pressure to meet minimum flow requirements.

Cleaver-Brooks offers blowdown piping and valves as an option for CFH boilers. Whether supplied by Cleaver-Brooks or others, blowdown equipment is required for all steam boilers.

A qualified boiler and piping installer should make all boiler waterside connections.

Warning

Only properly certified personnel such as the safety valve manufacturer's certified representative can adjust or repair the boiler safety valves. Failure to follow this warning could result in serious personal injury or death.

2.7-Electrical Connections

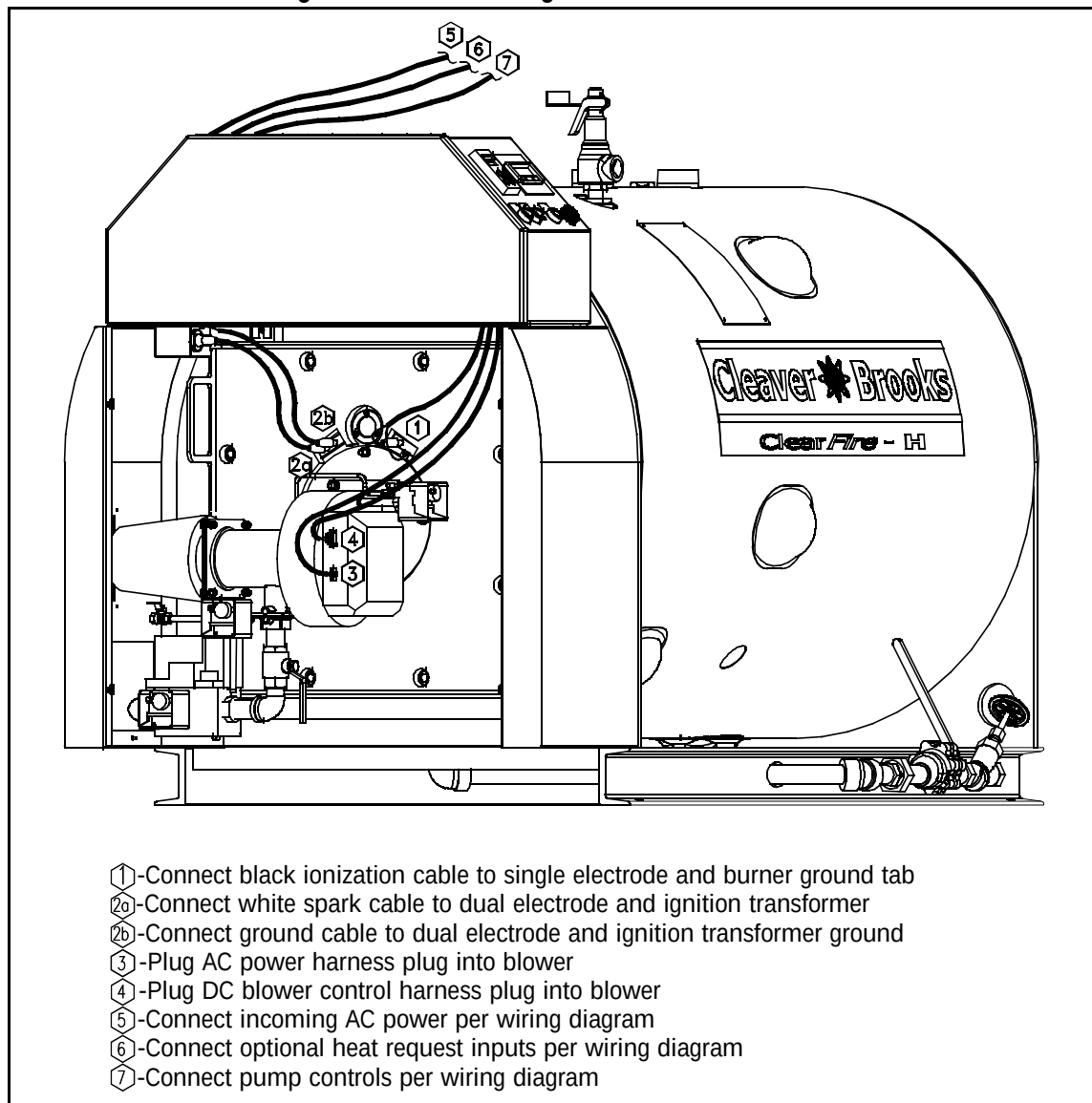
Refer to **Figure 2-6** for CFH wiring and cable connections.

A qualified electrician or service technician must make the electrical connections to the boiler; all local electrical and building codes should be adhered to.

Main power and any remote wiring should be brought to the left side of the control panel and terminated at the appropriate terminals provided.

For specific information on your boiler electrical control system see **Figure 2-7** or refer to the Cleaver-Brooks wiring diagram provided with the boiler.

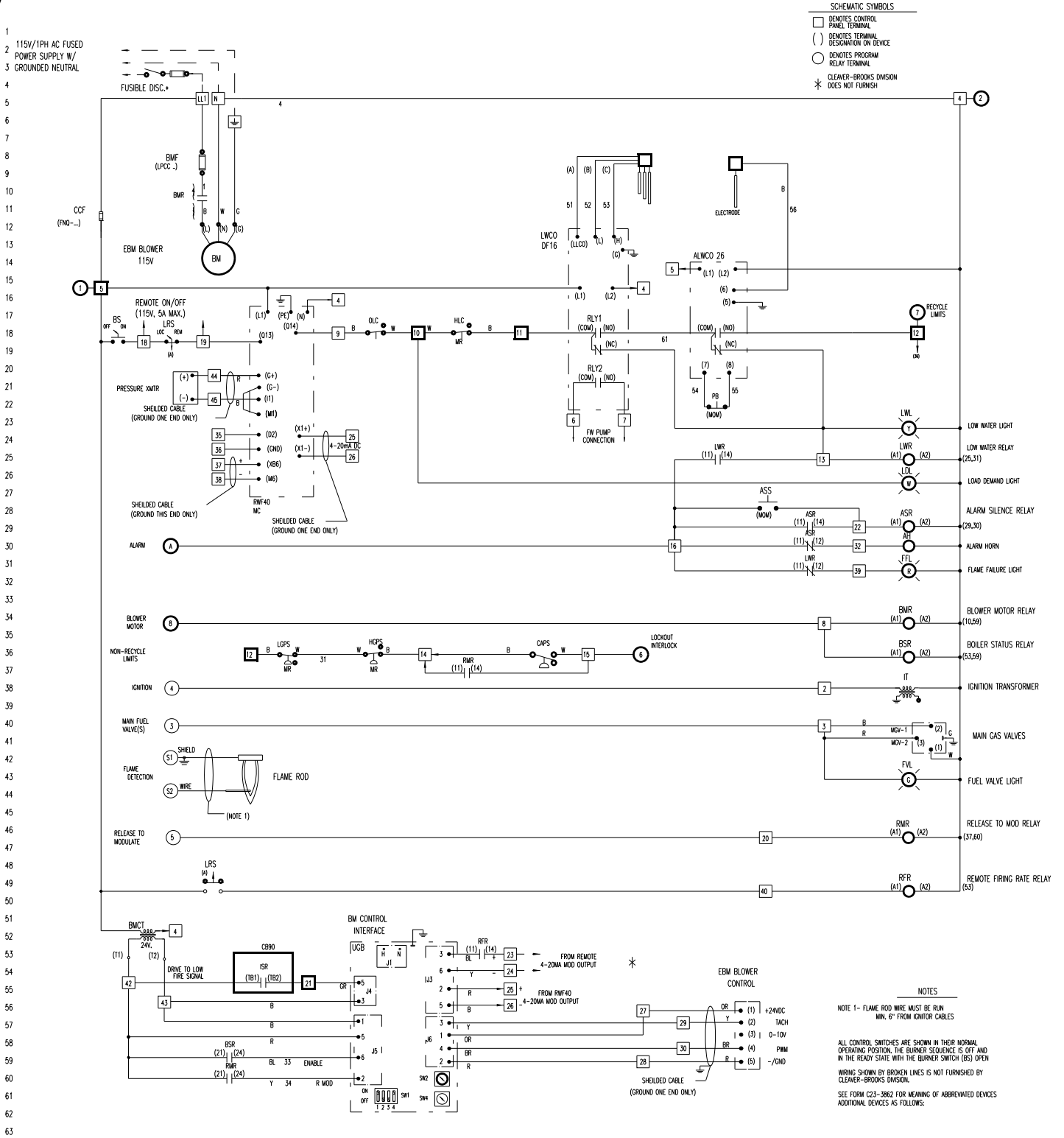
Figure 2-6 CFH wiring and cable connections



Notice

The blower signal wiring must be isolated from the blower power wiring and the high voltage ignition cables.

Figure 2-7 CFH Wiring Diagram





Chapter 3

Stack and Intake Vent Sizing and Installation

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3.1-Venting Connections — General

Proper installation of flue gas exhaust venting is critical for the efficient and safe operation of the ClearFire boiler.

Definition of Appliance Categories

Boilers are divided into four categories based on the pressure and temperature produced in the exhaust stack and the likelihood of condensate production in the vent.

- Category I. A boiler which operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
- Category II. A boiler which operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.
- Category III. A boiler which operates with a positive vent pressure and with a vent gas temperature that avoids excessive condensate production in the vent.
- Category IV. A boiler which operates with a positive vent pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

The ClearFire-H should be considered a Category III boiler. Depending on the application, the specifying engineer may dictate alternative category flue venting as deemed appropriate.

Notice

For additional information on boiler categorization, see latest edition standard of National Fuel Gas Code or in Canada, the latest edition of CGA Standard B149 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of local building codes.



Warning

Contact the manufacturer of the vent material if there is any question about the boiler categorization and suitability of a vent material for application on a Category III vent system. Using improper venting materials can result in personal injury, death or property damage.

Notice

During winter months check the vent cap and make sure no blockage occurs from build up of snow. Condensate can freeze on the vent cap. Frozen condensate on the vent cap can result in a blocked flue condition.

3.2-Vent Stack

The vent should be supported to maintain proper clearances from combustible materials.

Use insulated vent pipe spacers where the vent passes through combustible roofs and walls.

3.3-Vent Terminal Location

Give special attention to the location of the vent termination to avoid possibility of property damage or personal injury.

1. Combustion gases can form a white vapor plume in the winter. The plume could obstruct a window view if the termination is installed in close proximity to windows.
2. Prevailing winds could cause freezing of condensate and water/ice buildup on building, plants or roof.
3. The bottom of the vent terminal and the air intake shall be located at least 24 inches above grade, including normal snow line.
4. Un-insulated single-wall metal vent pipe shall not be used outside in cold climates for venting combustion gas.
5. Through-the-wall vents for Category II and IV appliances and non-categorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of other equipment. Where local experience indicates that condensate is a problem with Category III appliances, this provision shall also apply.
6. Locate and guard vent termination to prevent accidental contact by people and pets.
7. DO NOT terminate vent in window well, alcove, stairwell or other recessed area, unless previously approved by local authority.
8. DO NOT terminate above any door, window, or gravity air intake. Condensate can freeze causing ice formations.
9. Locate or guard vent to prevent condensate from damaging exterior finishes. Use a 2' x 2' rust resistant sheet metal backing plate against brick or masonry surfaces.
10. DO NOT extend exposed stack pipe outside of building. In winter conditions condensate could freeze and block stack pipe.
11. Multiple direct stack installations require a four (4) foot clearance between the stack caps, center to center.

U.S. Installations- Refer to latest edition of the National Fuel Gas Code.

Vent termination requirements are as follows:

1. Vent must terminate at least four (4) feet below, four (4) feet horizontally, or one (1) foot above any door, window or gravity air inlet to the building.
2. The vent must not be less than seven (7) feet above grade when located adjacent to public walkways.
3. Terminate vent at least three (3) feet above any forced air inlet located within ten (10) feet.
4. Vent must terminate at least four (4) feet horizontally, and in no case above or below unless four (4) feet horizontal distance is maintained, from electric meters, gas meters, regulators, and relief equipment.
5. Terminate vent at least six (6) feet away from adjacent walls.
6. DO NOT terminate vent closer than five (5) feet below roof overhang.

Canada Installations- Refer to the latest edition of CAN/CGA-B149.1 and B149.2

A vent shall not terminate:

1. Directly above a paved sidewalk or driveway which is located between two single family dwellings and serves both dwellings.
2. Less than 7 ft. (2.13m) above a paved sidewalk or paved driveway located on public property.
3. Within 6 ft. (1.8m) of a mechanical air supply inlet to any building.
4. Above a meter/regulator assembly within 3 ft. (900mm) horizontally of the vertical center-line of the regulator.
5. Within 6 ft. (1.8m) of any gas service regulator vent outlet.
6. Less than 1 ft. (300mm) above grade level.
7. Within 3 ft. (1m) of a window or door which can be opened in any building, any non-mechanical air supply inlet to any building to the combustion air inlet of any other appliance.
8. Underneath a verandah, porch or deck, unless:
 - A. The verandah, porch or deck is fully open on a minimum of two sides beneath the floor.
 - B. the distance between the top of the vent termination and the underside of the verandah, porch or deck is greater than 1 ft. (30cm)

Note: For sealed vent installations where the air is piped in from outside, a protective screen on the air inlet termination elbow must be used to act as an inlet screen.

 Warning

Examine the venting system at least once a year Check all joints and vent pipe connections for tightness, corrosion or deterioration.

Venting Installation Tips

Support piping:

- horizontal runs- at least every five (5) feet.
- vertical runs - use braces:
- under or near elbows

 Caution

Observe the following to avoid personal injury or property damage:

- To cut nonmetallic vent pipe, use a fine-toothed hacksaw (34 teeth per inch).
- Do not use nonmetallic vent pipe or fittings that are cracked or damaged.
- Do not use nonmetallic vent fittings if they are cut or altered.
- Do not drill holes, or use screws or rivets, in nonmetallic vent pipe or fittings.

3.4-Horizontal Thru-Wall Venting Inside Air (Category III)

For boilers connected to gas vents or chimneys, vent installations shall be in accordance with Part 7, Venting of Equipment, of the latest edition of National Fuel Gas Code, or in Canada, the latest edition of CAN/CGA-B 149.1 and.2 Installation Code for Gas Burning Appliances and Equipment, or applicable provisions of local building codes.

These installations utilize the boiler-mounted blower to vent the combustion products to the outside. Combustion air is taken from inside the room and the vent is installed horizontally through the wall to the outside. Adequate combustion and ventilation air must be supplied to the boiler room in accordance with the National Fuel Gas Code or, in Canada, the latest edition of CAN/CGA-B 149.1 and.2 Installation Code for Gas Burning Appliances and Equipment.

The direct vent cap is not considered in the overall length of the venting system.

The vent must be installed to prevent the flue gas leakage. Care must be taken during assembly to insure that all joints are sealed properly and are airtight.

The vent must be installed to prevent the potential accumulation of condensate in the vent pipes. It is recommended that:

1. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the vent terminal.
2. The vent be insulated through the length of the horizontal run.

For appliances installed in extreme cold climate, it is recommended that:

1. The vent be installed with a slight upward slope of not more than 1/4" per foot of horizontal run to the vent terminal. In this case, an approved condensate trap must be installed per applicable codes.
2. The vent be insulated through the length of the horizontal run.

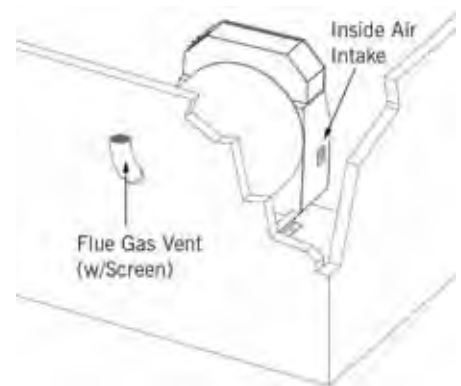


Figure 3-1 Horizontal Venting Thru-Wall Using Inside Air For Combustion

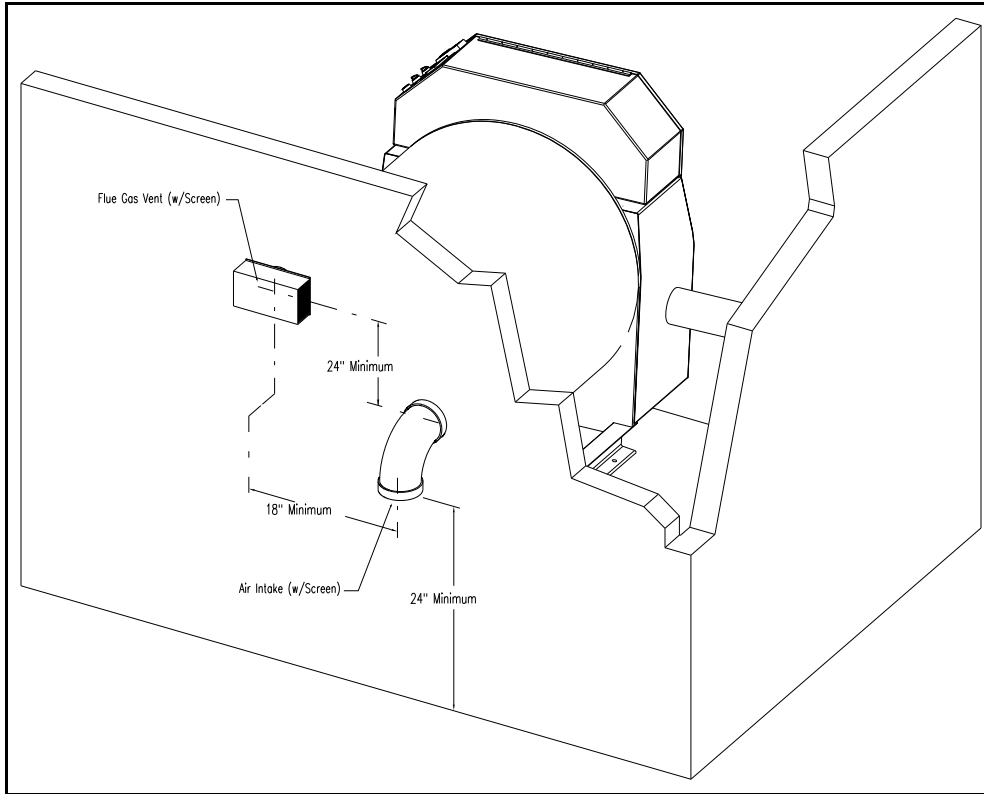


Figure 3-2 Horizontal Thru-wall Direct Venting System Category III Installation (Sealed Combustion Air/Stack Venting)

3.5-Horizontal Thru-wall Direct Venting

These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion gases to the outside.

The sealed combustion air vent cap is not considered in the overall length of the venting system.

Care must be taken during assembly that all joints are sealed properly and are airtight for both the combustion air intake and the exhaust stack piping system.

The stack vent must be installed to prevent the potential accumulation of condensate in the stack pipes. It is recommended that:

1. The vent be installed with a slight downward slope of not more than 1/4" per foot of horizontal run to the stack terminal.
2. The stack vent is to be insulated through the length of the horizontal run.

For appliances installed in extreme cold climate, it is recommended that:

1. The stack vent be installed with a slight upward slope of not more than 1/4" per foot of horizontal run to the vent terminal. In

this case, an approved condensate trap must be installed per applicable codes.

2. The stack vent is to be insulated through the length of the horizontal run.

3.6-Horizontal Thru-wall Stack Vent Termination

The stack vent cap **MUST** be mounted on the exterior of the building. The stack vent cap cannot be installed in a well or below grade. The stack vent cap must be installed at least one (1) foot above ground level and above normal snow levels.

Multiple stack vent caps should be installed in the same horizontal plane with a three (3) foot clearance from the side of one stack cap to the side of the adjacent stack vent cap(s).

Combustion air supplied from outside must be free of particulate and chemical contaminants. To avoid a blocked flue condition, keep all the vent caps clear of snow, ice, leaves, debris, etc.

Caution

Multiple direct stack vent caps **MUST NOT** be installed with a combustion air inlet directly above a stack vent cap. This vertical spacing would allow the flue products from the stack vent cap to be pulled into the combustion air intake installed above. This type of installation can cause non warrantable problems with components and poor operation of the unit due to the recirculation of flue products.

3.7-Vertical Venting Inside Combustion Air (Category III) Central Heating

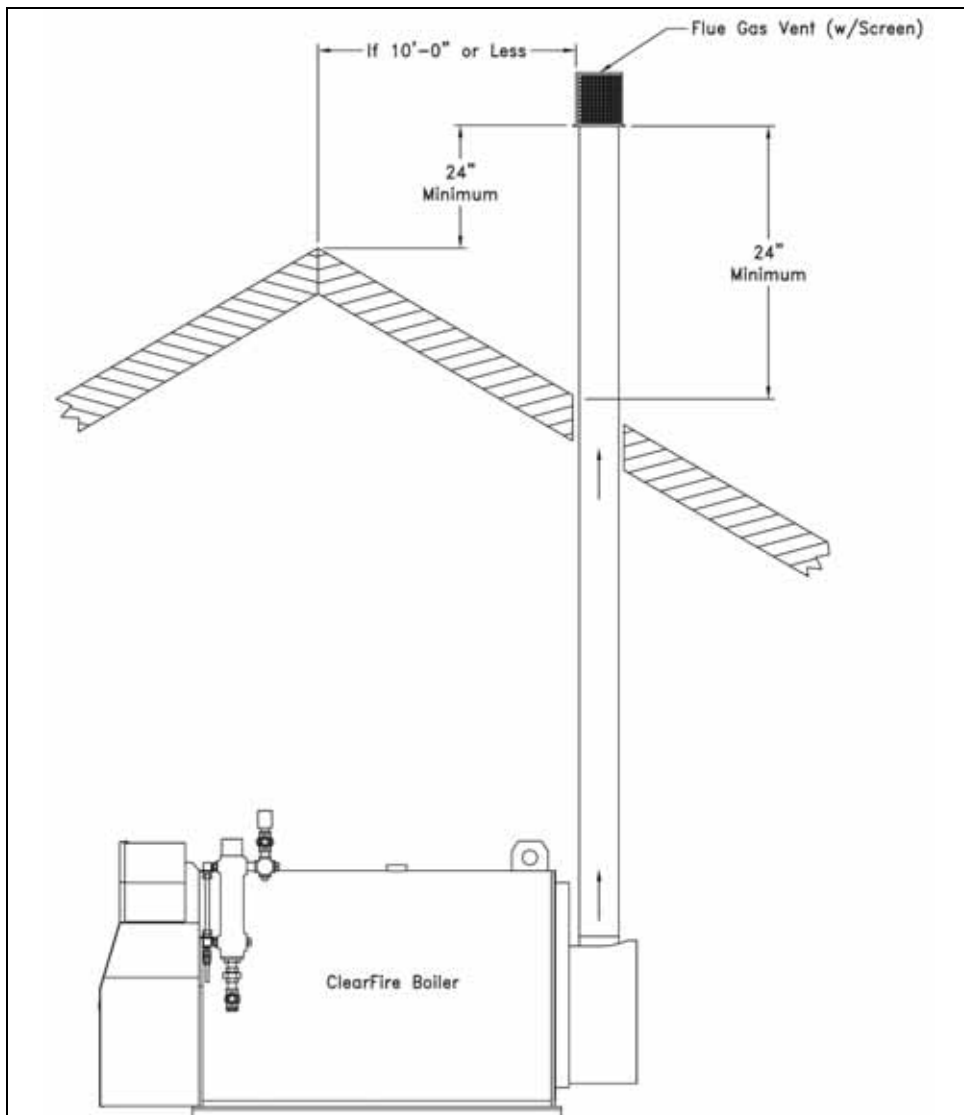


Figure 3-3 Vertical Stack with Inside Combustion Air

These installations utilize the boiler mounted blower to vent the combustion products to the outside. Combustion air is taken from inside the room and the vent is installed vertically through the roof to the outside. Adequate combustion and ventilation air must be supplied to the boiler room in accordance with the National Fuel Gas Code or, in Canada, the latest edition of CAN/CGA-B 149.1 AND.2. Installation Code for Gas Burning Appliances and Equipment.

To prevent condensation accumulation in the vent, it is required to install the horizontal portion of vent with a slight upward slope of not more than 1/4" per foot of horizontal run and an approved condensate trap must be installed per applicable codes.

**Warning**

The Stainless Steel non-restricted direct vent cap must be furnished in accordance with AGA/CGA requirements.

No substitutions of flue pipe or vent cap material are allowed. Such substitutions would jeopardize the safety and health of inhabitants.

3.8- Vertical Venting Direct Sealed Combustion Air (Category III)

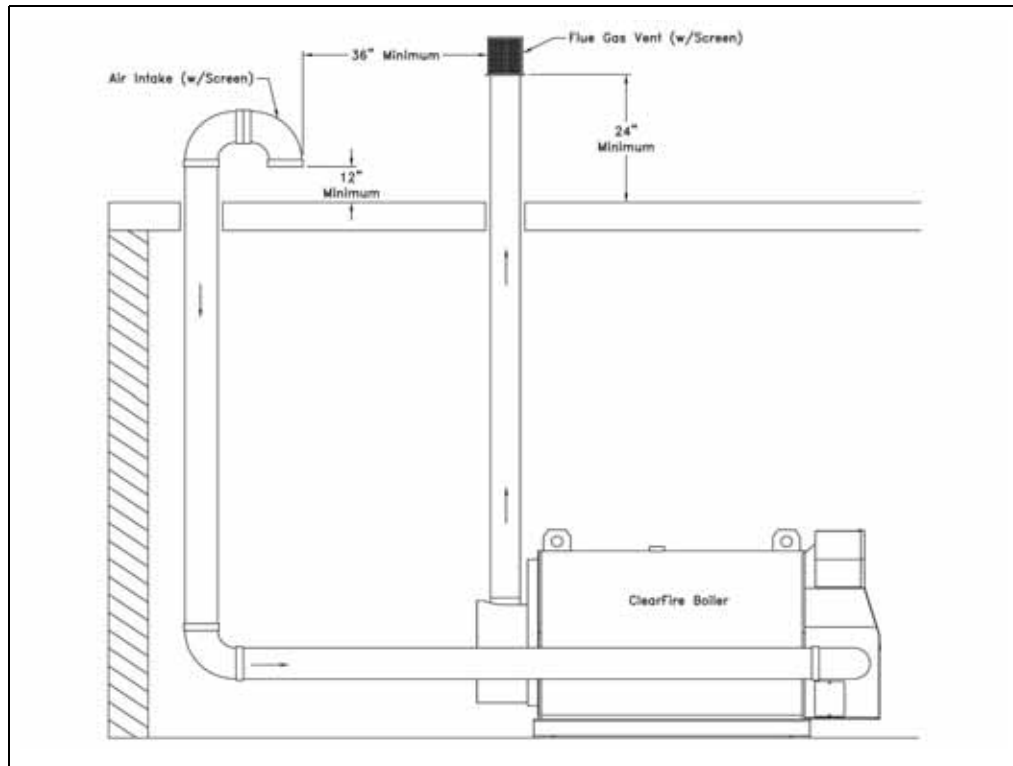


Figure 3-4 Vertical Stack with Sealed Combustion Air

These installations utilize the boiler mounted blower to draw combustion air from outside and vent combustion products to the outside. A positive pressure venting system is required.

To prevent condensation accumulation in the vent, it is required to install the horizontal portion of vent with a slight upward slope of not more than 1/4" per foot of horizontal run; an approved condensate trap must be installed per applicable codes.



Chapter 4 Commissioning

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Warning

The boiler and its gas connection must be leak tested before placing the boiler in operation.

4.1-Operating Conditions

- The installation site should be as free as possible from vibration, dust, and corrosive media
- The controllers should be located as far as possible from sources of electromagnetic fields, such as frequency converters or high-voltage ignition transformers
- Control panel must be connected to earth ground.

Boiler room ambient conditions	
Relative humidity	≤ 85-90%
Ambient temperature range	0 °C to 50 °C / 32°F to 122°F
Storage temperature range	-20 °C to 60 °C / -4°F to 140°F

NOTE: If hydrostatic testing is required on site, use water at 70 deg. F and pressure not to exceed 90% of the safety valve rating.

4.2-Filling Boiler

Open the manual bleed valve before allowing water to enter into the boiler. Make sure the drain valve is closed. The boiler should be filled slowly to allow air to escape while water fills the boiler. Do not close the manual vent valve until the feed water pump shuts off. When it does, close the valve. Check to ensure that no leaks appear at any pipe connections and correct if water leaks are noticed.

4.3-Control Setpoints

Preliminary settings of the burner/boiler controls are necessary for the initial starting of the boiler. After the burner has been properly set, minor adjustments to these controls may be necessary for the particular installation. For initial starting, set the following controls accordingly:

1. Operating and High Limit Controls - Set the dial @ maximum.
2. Combustion Air Proving Switch - Set the dial @ minimum.
4. Low Gas Pressure Switch - Set the dial @ minimum.
5. High Gas Pressure Switch - Set the dial @ maximum.

Depress all manual reset buttons for all controls prior to starting.

4.4-ClearFire-H Boiler / Burner Controls

The ClearFire-H primary boiler/burner controls include the following:

- RWF40 modulating control
- CB90 flame safety control
- UGB variable speed blower interface
- Low water cut-off and pump control (LWCO)
- Auxiliary low water cut-off (ALWCO)
- Operating and high limit controls (OLC and HLC)



Figure 4-1 Boiler Controls

Please review the tables within this Commissioning section to familiarize yourself with the functions and parameters of the Controllers.



Warning

The ClearFire-H is factory tested. Nevertheless, all burner safety controls should be checked upon installation, prior to initial firing. **Failure to verify burner control functioning could result in severe bodily injury or death.**

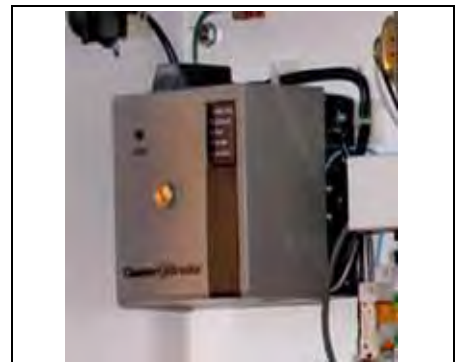


Figure 4-2 CB90 Unit

A. Modulating Control Configuration and Operation

The RWF40 modulating control is located externally at the right side of the control panel for convenient access to all operating controls. A steam pressure transmitter mounted at the control trim piping provides the measured process variable signal to the RWF40 controller. The RWF40 modulating controller should be factory configured for the specific CFH boiler application. Prior to starting the boiler, verify that these settings are correct for your application. Please refer to CB default settings, Table 4-1, for your specific application. Make any changes at this time if needed.

The basic display indicates measured process variable and modulating set point. The controller will always return to the basic display automatically if no key is pressed for 30 seconds.

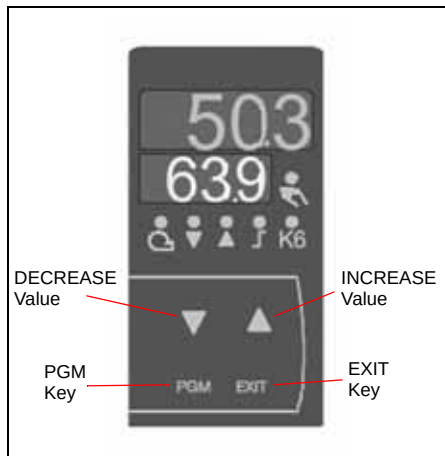


Figure 4-3 RWF40

User level settings consist of the modulating set points (SP1 & SP2). These set points can be accessed by pressing the <PGM> key. Change the setting by pressing the <UP> and <DOWN> keys until the desired set point is displayed. Press the <PGM> key to save the new setting – displayed value will flash to indicate it has been saved. Allowable set point range is limited by Configuration parameters SPL & SPH (see Configuration settings, Table 4-1). Return to the basic display by pressing the <EXIT> key.

Parameter level settings include PID settings (Pb = proportional band, dt = derivative time, rt = integral time), differential on (HYS1), and differential off (HYS3) settings. To access the Parameter level, press and hold the <PGM> key for 3 seconds, then release. The current parameter value will be displayed in red. The current parameter will be shown in green. By pressing the <PGM> key, one can advance through the parameters to reach the parameter that requires review or a change. Settings are changed using the <UP> and <DOWN> arrow keys and saved by pressing the <PGM> key. Return to the basic display by pressing the <EXIT> key.

Configuration level settings should be factory set and rarely require adjustment. **Please note: only qualified CB factory and service personnel should make changes to Configuration level settings.** If adjustment is necessary, this level can be accessed by first accessing the Parameter level as described above. Once at the Parameter level, repeat press and hold of the <PGM> key for another 3 seconds, then release. One can advance through the Configuration settings by pressing the <PGM> key. Changes to Configuration parameters C111, C112 & C113 are performed by pressing the <DOWN> arrow key to select the digit that requires changing, then press the <UP> arrow key to change the digit to the value desired. Repeat until each digit is set to the proper value. Once the specific C11x parameter is correct, press the <PGM> key to save. Other Configuration parameters, such as set point limiting (SPL & SPH) and remote set point scaling (SCL2 & SCH2) are changed and saved as described above in User and Parameter levels.

Table 4-1 RWF40 MODULATING BOILER CONTROL Factory default configuration

<u>User Level</u>	<u>Functions</u>	<u>15# Steam</u>	<u>150# Steam</u>	<u>RWF40 Default</u>
SP1	Set Point 1	10	100	60
SP2	Set Point 2	10	100	60
dSP	digital Set Point shift	0	0	0
tA	Outdoor Air Temperature (An3)	current reading	current reading	*C111 = xx3x
SPE	Remote (External) Set Point (An2)	current value	current value	*C111 = x3xx or x4xx
<u>Parameter Level</u>	<u>Functions</u>	<u>15# Steam</u>	<u>150# Steam</u>	<u>RWF40 Default</u>
AL	K6 relay alarm level	0	0	0
HYS1	K6 relay alarm differential	1	4	1
Pb	PID - Proportional Band	25	25	10
dt	PID - Derivative time	0	0	80
rt	PID - Integral time	150	150	350
db	NA	1	1	1
tt	NA	15	15	15
HYS1	Differential On	0	0	-5
HYS2	NA	3	3	3
HYS3	Differential Off	2	6	5
q	NA	0	0	0
H	NA	1	1	1
P	NA	0	0	0
<u>Configuration Level</u>	<u>Functions</u>	<u>15# Steam</u>	<u>150# Steam</u>	<u>RWF40 Default</u>
C111	An Input 1, An2, An3, Dual SP	F001	F001	9030
		(4-20mA)	(4-20mA)	
C112	Modulating 4-20mA output	0200	0200	0010
C113	Modbus address, deg F, K6 off	0130	0130	0110
SCL	Scale Analog Input 1 Low	0	0	0
SCH	Scale Analog Input 1 High	15	150	100
SCL2	Scale Analog Input 2 Low	0	0	0
SCH2	Scale Analog Input 2 High	13.5	135	100
SPL	Set Point Low Limit	0	0	0
SPH	Set Point High Limit	13.5	135	100
OFF1	Offset correction, An1	0	0	0
OFF2	Offset correction, An2	0	0	0
OFF3	Offset correction, An3	0	0	0
dF1	Digital Filter, An1	1	1	1

Basic display indicates the measured process variable (steam pressure or hot water outlet temperature) at the top in red with the current modulating set point below it in green. A green LED above the burner symbol indicates operating status: ON indicates the burner is released for modulation; OFF indicates the boiler process variable has exceeded the off point ($SPx + HYS3$) and has yet to reach the on point ($SPx - HYS1$). The LED will turn ON and the burner will be released for modulation when the process variable falls below the ON point (please note - this LED does not necessarily indicate that the burner is operating - it merely indicates that the modulating control has released the burner for operation).

To enter manual firing rate control from the basic display, press and hold the <EXIT> key for 5 seconds, then release. A red LED will turn ON to indicate the controller has switched to manual firing rate control. The current control output (0-100%) will be displayed in green. **Please note: the firing rate will always start at 0% when first entering manual operation.** Change the manual firing rate by pressing the <UP> and <DOWN> arrow keys until the desired rate is displayed. Once the key is released, the displayed control output will flash indicating the new firing rate has been saved. The burner should modulate to this firing rate accordingly. Return to automatic firing rate control by pressing and holding the <EXIT> key for 5 seconds, then release.

For more information see the RWF40 User Hints (Appendix B in this manual). If additional help is needed, contact your Cleaver-Brooks representative.

B. Flame Safety Control Operation

The CB90 flame safety control is located in the control panel at the front of the boiler. The CB90 control is factory configured for operation with all CFH boiler applications. The control is mounted inside the control panel. The LED's indicate operating status and alarm/lockout conditions. The manual reset button should be pressed to clear any lockout condition after the condition has been remedied. Please refer to the CB90 manual in Appendix C of this manual for details on operation, sequencing, wiring, etc.

The CFH boiler uses direct spark ignition (no gas pilot) to light the main flame. Flame sensing is accomplished with a flame rod, or ionization electrode. **Please note: PTFI indication actually refers to the main trial for ignition period.**



Figure 4-4 CB90 Flame Safety Control

Basic burner sequencing:

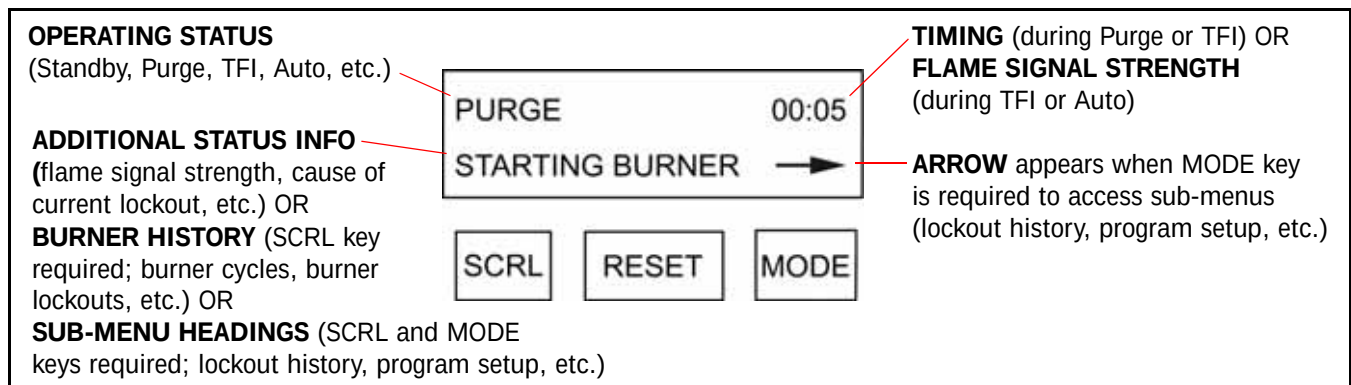
1. Standby, limits open
2. Limits closed
3. Blower enable – blower starts and attains high fire speed
4. High fire purge (30 sec.), air flow interlock (10 sec. delay; air failure lockout after 3rd purge attempt or during ignition trial

5. Intermediate ignition speed (allow 10 sec. to stabilize),
~30% of HF
6. Main Trial For Ignition (PTFI), 4 sec.
 - a. Ignition energized
 - b. Main Fuel Valve energized
 - c. Flame supervision, lockout on flame failure
7. Flame proved then 5 sec. stabilization period
8. Auto/Release to Modulate
9. Main Fuel Valve de-energized
10. Post purge (15 sec.)
11. Blower stop, standby

External Display (optional)

The optional externally mounted CB90 display is mounted on the right side of the control panel. The CB90 display indicates current burner status, first out alarm in the event of a lockout condition, historical burner information, detailed lockout information of the last six (6) lockout conditions, and programmer configuration information. Through the display the ability to program the unit address for communications, as well as resetting the stored information (cycles, hours, and lockouts) to zero is provided.

Information appears on the screen in the following locations:



Any time the CB90 is powered on, the **SCRL** key can be used to scroll through and display the total burner hours, burner cycles, burner lockouts, and system hours on the bottom line of the display. The top will continue to show the current run mode (e.g. PURGE, AUTO, etc.). Following the historical information, the **SCRL** key will display three sub-menus providing the following information and/or functions:

Lockout History (with burner cycle and burner hour time stamp)

Program Setup (to display programmer type, purge timing, switch configuration, etc.)

System Information (values of average pilot and main flame signal, and reset burner history)

Please note: normal indicated flame signal is between 26 and 42.

The **MODE** key is used to access the system sub-menus. An arrow will appear in the lower right hand corner of the display when a sub-menu is available. Once within a sub-menu, the **SCRL** key will show the next item in the menu, and the **MODE** key will exit the sub-menu and return the display to the main menu.

Lockout History

The LOCKOUT HISTORY sub-menu shows the last six lockouts, along with the burner cycle and burner hour when the lockout occurred. Pressing the **MODE** key shows the number and description of the most recent lockout (see example below). The **SCRL** key shows the burner hour, followed by the burner cycle when the lockout occurred. Pressing **SCRL** again advances through the lockout list, repeating the above sequence. The **MODE** key returns to the main menu.

Use of Test Meter

Testing the CB90 Control requires the use of a test AC/DC multimeter, with a minimum 1000 ohm/volt AC scale and 20,000 ohm/volt DC scale. With the test meter on the DC scale, and the test meter leads inserted into the test jacks on the amplifier (Red for positive (+) polarity, Black for minus (-) polarity), a DC voltage reading of 4.0 to 10 volts for all amplifier types should be obtained when the control is detecting flame and 0 volts when no flame is present. Wildly fluctuating readings are an indication of an unstable flame or flame sensor requiring maintenance. Inadequate flame signal may be improved by:

1. Assuring that the flame detector and wiring installation is correct.
2. Assuring that the flame detector is clean and in the correct position (see Fig. 5-7 & Fig. 5-8).
3. Assuring that the flame is sufficiently large to detect.
4. Assuring that the flame quality (fuel to air ratio, combustion air velocity) is satisfactory.
5. Re-positioning the flame detector for better flame sensing. (**A Cleaver-Brooks representative should be consulted before mechanical changes are made**).

When using a flame rectification amplifier, a micro-ammeter may be connected in series with the wire to Terminal S2. Normal flame will produce a meter reading between 4 and 10 micro-amperes.

With the test meter on the AC scale, line and load voltages may be measured at the identified test points on the chassis.

C. Variable Speed Blower Interface

The UGB variable speed blower interface is located in the control panel at the front of the boiler (Figure 4-5). The UGB receives inputs from the CB90 and RWF40 controls which control the premix blower through the burner safety sequence and modulation. The settings of this interface are critical for proper operation of the CFH boiler. Please check that these settings are correct prior to operation of the boiler. UGB settings are found in Table 4-2. Please see Fig. 4-6 for locations of each shunt (jumper) and switch.

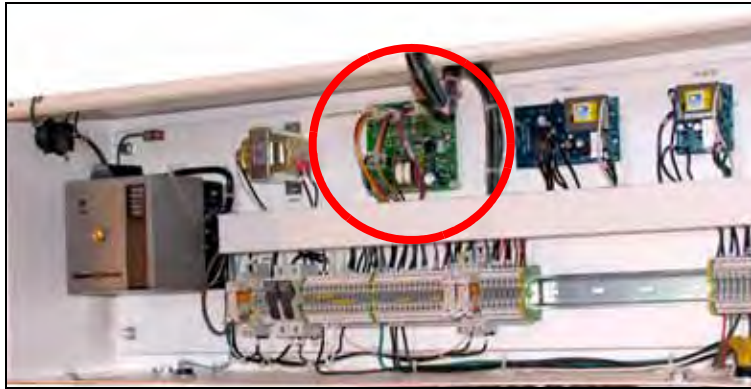


Figure 4-5 UGB Interface

Table 4-2 UGB Settings

PREMIX BLOWER CONFIGURATION				UGB Board Settings:			Shunt position *		
Boiler HP	CB P/N	Blower Model	Voltage	SW1**	SW2	SW4	JP1	JP2	P6
10	894-4076	G1G170-AB05-20	115	see below	1	9	removed	installed	pins 2&3
15	894-4076	G1G170-AB05-20	115	see below	2	D	removed	installed	pins 2&3
20	894-4076	G1G170-AB05-20	115	see below	1	9	removed	installed	pins 2&3
25	894-4076	G1G170-AB05-20	115	see below	1	9	removed	installed	pins 2&3
30	894-4076	G1G170-AB05-20	115	see below	2	B	removed	installed	pins 2&3
40	894-4111	G3G200-GN26-01	115	see below	3	E	removed	installed	pins 2&3
40(Hi Alt.)	894-4075	G3G250-GN39-01	115	see below	2†	9†	removed	installed	pins 2&3
40(Hi Alt.)	894-4116	G3G250-GN44-01	230	see below	2†	A†	removed	removed	pins 2&3
50	894-4075	G3G250-GN39-01	115	see below	2	D	removed	installed	pins 2&3
60	894-4075	G3G250-GN39-01	115	see below	3	E	removed	installed	pins 2&3

*Shunt pins Description

JP1	Remove shunt for burner sequencing with CB90		
JP2	Blower specific		
P6 (3-pin)	Soft start:	1&2 = 50%	2&3 = 30%

**UGB SW1

SW1 - DIP switch settings			
ON			ON
	OFF	OFF	
1	2	3	4

†For high altitude (> 1500' ASL) applications, SW2 and SW4 should be increased to compensate for reduced combustion air density

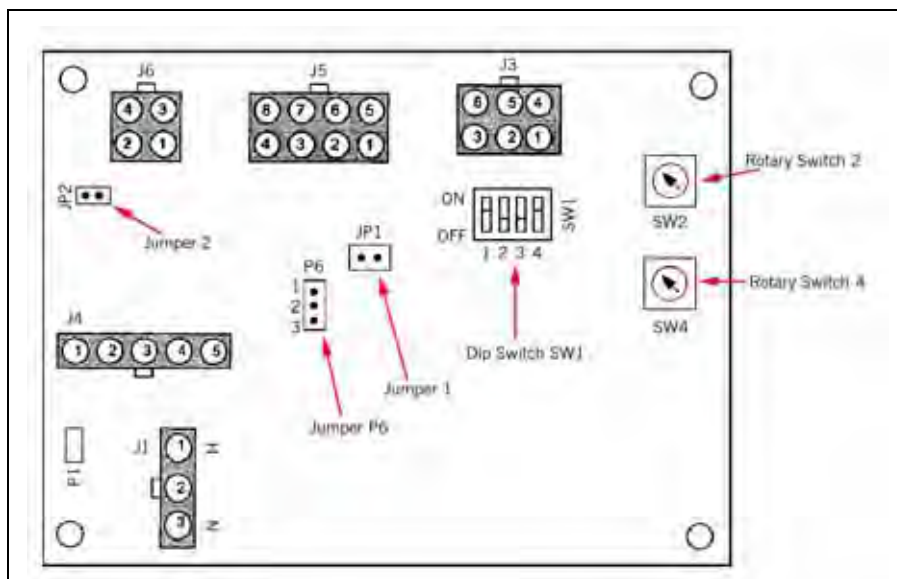


Figure 4-6 UGB switch and jumper locations



Important: Changes to SW1 DIP switches and jumper positions must be made with power disconnected from the control panel.



Caution

Setting SW2 too low or SW4 too high can lead to under or over firing of the CFH boiler. Both conditions can be hazardous and are likely to shorten the life of the burner and/or boiler.

Jumper JP1 should always be removed. Jumper JP2 remains or is removed, depending on the specific premix blower on your boiler. Jumper P6 should be connected to pins 2 & 3 for 30% rate ignition speed.

SW1 actually consists of four DIP switches. These need to be set to the positions shown in Table 4-2 for proper operation of the CFH boiler.

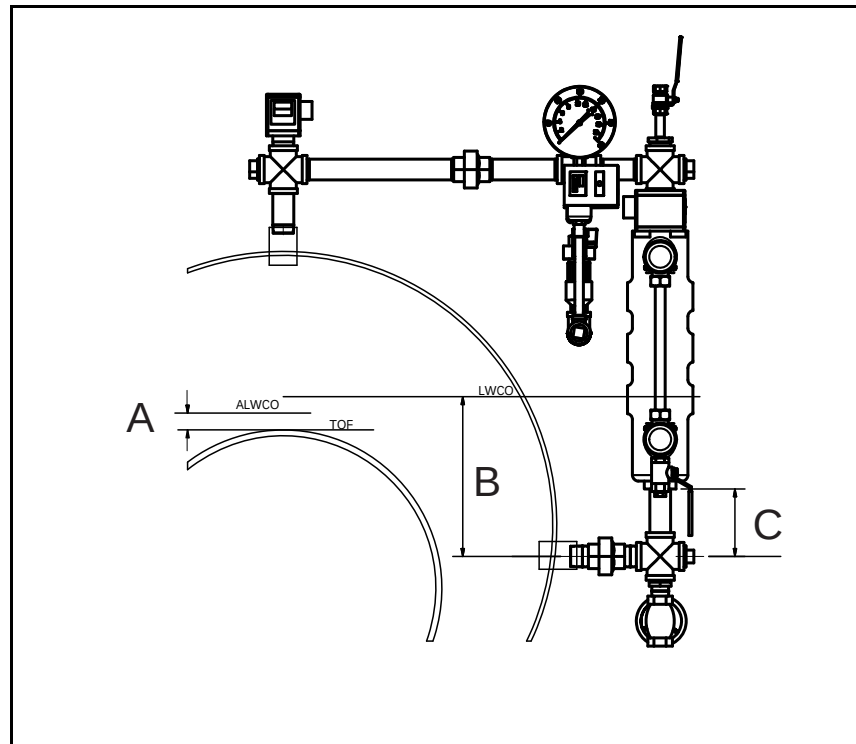
SW2 and SW4 rotary switches limit the minimum and maximum blower speeds – and corresponding minimum and maximum firing rate -- respectively. It is important that these switches be set at the factory recommended settings, especially at initial start up. Some fine tuning of these switches is allowed to suit the installation if a gas meter is available to check actual fuel input at low and high fire rates. SW2 and SW4 can be adjusted during burner operation.

D. Water Level Controls

The LWCO/pump control and ALWCO control boards are located in the control panel at the front of the boiler. The LWCO control is connected to conductance probes mounted within the external water column. This column has 4 probes used for the following functions: low water cut-off, pump on, pump off, and high water alarm (optional). The ALWCO control is connected to a conductance probe(s) in either a vessel-mounted probe head or optional external column. The ALWCO includes a panel mounted manual reset/test switch.



**Figure 4-7 Control circuitry
LWCO and ALWCO**



	10-15 HP 15# Steam	10-15 HP 150# Steam	20-25 HP 15# Steam	20-25 HP 150# Steam	30-40 HP 15# Steam	30-40 HP 150# Steam	50-60 HP 15# Steam	50-60 HP 150# Steam
A	1 1/16" + 1/16"; - 0"	3 1/16" + 1/16"; - 0"	1 1/16" + 1/16"; - 0"	3 1/16" + 1/16"; - 0"	1 1/16" + 1/16"; - 0"	3 1/16" + 1/16"; - 0"	1 1/16" + 1/16"; - 0"	3 1/16" + 1/16"; - 0"
B	9 1/16"	11 1/16"	10 1/16"	12 1/16"	10 1/16"	12 1/16"	11 3/4"	13 3/4"
C	3 1/4" E 1/16"	5 1/4" E 1/16"	4 1/4" E 1/16"	6 1/4" E 1/16"	4 1/4" E 1/16"	6 1/4" E 1/16"	6" E 1/16"	8" E 1/16"

CFH Probe and WC Levels

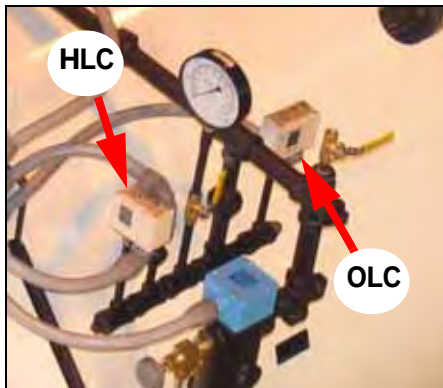


Figure 4-8 Limit Controls

Warning

Before initial startup, check for blockages in the flue venting or vent terminations. Inspect the burner and furnace for any contamination or blockages.



Figure 4-9 Blower Housing, Gas Valve & Mixing Venturi

E. Operating and High Limit Controls

The operating (OLC) and high pressure limit (HLC) controls are externally mounted to the control trim piping. The setting of the OLC should be slightly higher than the configured set point plus the differential off (SPx + HYS3) value of the RWF40 modulating control. The setting of the HLC should be slightly higher than the OLC. For example:

RWF40, SP1 = 100.0 psig, HYS3 = 5.0 psig
OLC could be set to 110 psig, HLC set to 120 psig

Specific settings are determined by application and system control scheme.

After all settings are verified and with boiler controls at proper settings, the boiler can be connected to power and the burner commissioning can be initiated.

4.5-Initial start-up procedure

A. Gas Train and Piping

The ClearFire burner is equipped with a combination servo-regulated gas valve and venturi mixing unit (see Figures 4-9, 4-10). The gas valve consists of a single body with dual solenoid shut off valves, filter screen, and a built-in constant pressure gas/air servo controller. The blower is controlled by the RWF40 with airflow relative to the speed of the fan. The airflow creates a drop in pressure due to the venturi effect. The servo controller of the valve actuator senses air pressure change and accordingly brings about a change in the gas flow proportional to the air pressure. The gas follows the airflow in a given ratio, so that fuel always follows the air as the burner firing rate increases or decreases.

1. Check the gas delivery system to be sure it is properly piped and wired.
2. Review available gas pressure to assure it is compatible with the main gas regulators upstream of the ClearFire-H gas train. **Note:** The maximum rated inlet pressure to the CFH gas train is 1 psig (27.7" WC). An upstream regulator and overpressure protection are required if building supply gas pressure is greater than 1 psig.
3. To bleed air from the supply pipe, open the manual gas shut off valve upstream of the burner gas train and bleed air from the piping by loosening the union in the upstream piping.
4. The burner and its gas connection must be leak tested before placing the boiler into operation.
5. Gas Pressure Regulator - Using the adjusting screw on the main gas regulator, adjust the inlet pressure to the recommended levels in Table 4-3.

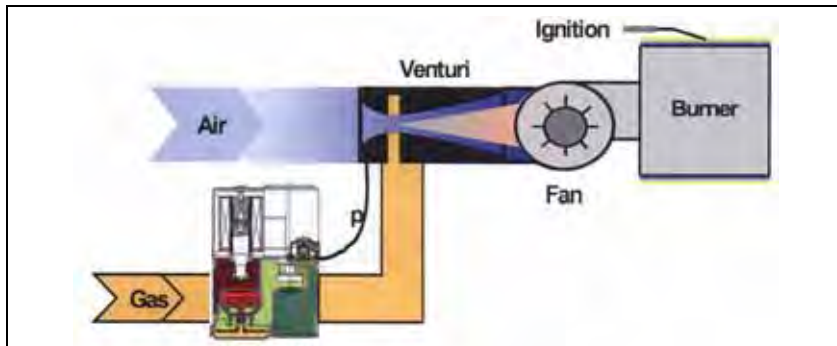


Figure 4-10 Premix Burner Technology - Full Modulation

Table 4-3 ClearFire-H Gas Pressure Requirements

Gas Train Pressure	Min. ("WC)	Max. ("WC)
10HP	7.2"	28"
15HP	7.3"	28"
20HP	7.5"	28"
25HP	7.7"	28"
30HP	8.8"	28"
40HP	11.0"	28"
50HP	9.5	28"
60HP	10.0	28"

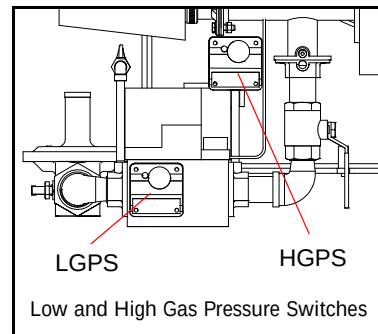
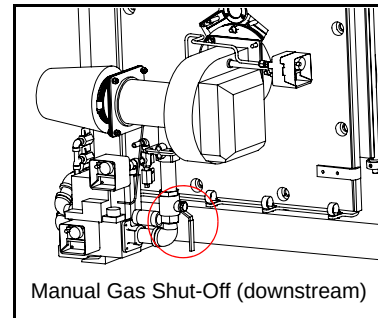
B. Power-Up

1. Ensure blower motor is properly wired for the available power supply. 115 V-1Ph-60Hz.
2. Verify the voltage (Control voltage is 115V-1Ph.) to ensure it is within specification for the application.
3. Set all limit and interlock switches to the appropriate setting for the application.

C. Operation Check: Gas Valve, Gas Pressure Switches, and Combustion Air Proving Switch

Before initial firing of the burner, the gas valve, Low Gas Pressure Switch (LGPS), High Gas Pressure Switch (HGPS), and Combustion Air Proving Switch (CAPS) should be checked for proper operation.

- Before proceeding, review **Section 4.3 - Control Setpoints** for initial LGPS, HGPS, and CAPS settings.
- Close the downstream manual shut-off valve before checking pressure switches and CAPS.



LGPS

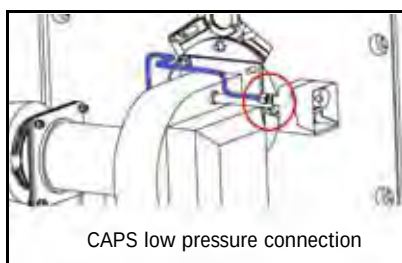
1. To check the Low Gas Pressure Switch, first close the upstream manual shutoff valve (both manual shutoff valves should now be closed).
2. Start the burner and wait 10 seconds during purge for CAPS to be made.
3. Turn the LGPS setting to maximum.
4. Open the test cock to bleed the gas line.
5. The CB90 should lock out, indicating LOCKOUT PURGE INTERLOCK OPEN.
6. Reset the CB90 and change the LGPS setting back to minimum to proceed.

HGPS

1. Open the upstream manual shutoff valve and wait a few moments for gas pressure to rise.
2. Lower the switch setting to minimum.
3. Initiate light-off sequence.
4. The CB90 should lock out on an interlock failure.
5. Reset CB90.
6. Dial the HGPS back to its maximum setting and reset; the lock-out condition should clear.

CAPS

1. Initiate burner sequence.
2. During purge cycle, set Combustion Air Proving Switch to its maximum setting.
3. The CB90 Flame Safety control should lock out on an airflow failure. CB90 display will show LOCKOUT PURGE INTERLOCK OPEN.



Note: If the CAPS fails to open even when set to maximum, test by disconnecting the low-pressure line to the switch and initiating burner sequence. The switch should now break during the purge cycle. Reconnect low-pressure side after a successful CAPS check.

4. Following a successful CAPS check, dial the CAPS back to its minimum setting and reset the CB90.

GAS VALVE

1. Initiate burner sequence. At PTFI (Trial for Ignition), verify gas valve LEDs energize, indicating both safety shutoff valves open.
2. A flame fail test can also be conducted at this time. With the gas shutoff closed while the burner attempts ignition, the CB90 Flame Safety should lock out indicating PTFI (ignition) failure. Reset as needed.

After verifying proper operation of LGPS, HGPS, CAPS, and Gas Valve, re-open the downstream manual shut-off valve.

D. LWCO and ALWCO Check

- Before testing low water controls, disconnect power to the feed pump.

LWCO

1. To verify proper LWCO operation, conduct a blowdown of the water column (refer to Chapter 5, Section 5.3 - Water Column Blowdown).
2. During WC blowdown, the burner should shut off when low water level is reached.
3. Upon shutdown, check the LWCO control board in the CFH electrical panel. The LED indicator should be off, indicating that the LWCO has switched off the control circuit.

ALWCO

1. To check the ALWCO, drain the boiler (refer to Chapter 5, Section 5.2 - Blowdown).
 2. Observe the ALWCO control board in the CFH electrical panel. When the ALWCO level is reached, the LED indicator should go out.
 3. Close the blowdown valves, refill boiler and reset the ALWCO.
- After testing the low water controls, reconnect power to the feed pump.

E. Low and High Fire Adjustments

Before initial firing of the burner, the integral gas regulator should be adjusted. Adjustments are made using a TORX® T40 (low fire adjustment) and 3 mm hex wrench (main gas choke). The adjustments should initially be set to half way through each setting's range. The low fire adjustment screw is accessed by removing the slotted cap on the gas regulator using a blade screwdriver (see Figure 4-11). The high fire adjustment screw is accessed by removing the blue plastic cap from the valve cover (see Figure 4-12).

Turn the adjustment screw completely clockwise, counting the turns until the screw will no longer turn. Then, turn the adjustment screw counterclockwise half the number of turns counted when turning clockwise.

NOTE:When adjusting low fire offset, clockwise adjustments *increase* gas flow, and counterclockwise adjustments *decrease* gas flow.

When adjusting the main gas choke, clockwise adjustments *decrease* gas flow, and counterclockwise adjustments *increase* gas flow.

Refer to Appendix A for further information on gas valve setup, operation, and testing.

F. Setting Combustion

Note: A Combustion Analyzer is mandatory to properly set-up the ClearFire-H burner. No attempt to fire and adjust the burner is permitted without this equipment.

Note: Ensure boiler is filled with water prior to burner startup.

The burner does not have need of linkages for fuel/air adjustment, nor is a separate manual-auto switch provided for burner positioning. All firing rate adjustments are accomplished via the RWF40 Control. Setting combustion will require manually

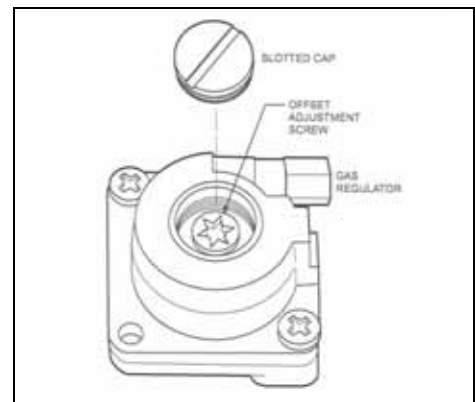


Figure 4-11 Regulating Adjusting Screw - Low Fire Offset



Figure 4-12 Main Gas Choke - High Fire Adjustment

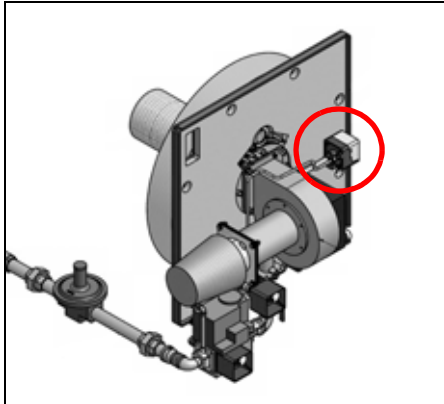


Figure 4-13 Combustion air proving switch

modulating the burner via the RWF40 from low fire to high fire two or more times to ensure a consistent air/fuel ratio.

1. Check inlet gas pressure and reset low gas pressure switch.
2. Review burner sequence before proceeding (see above, Section 4.4).
3. Initiate burner firing sequence. If the burner does not ignite, adjust choke counterclockwise slightly until you can see a slight yellow flame at the burner during ignition. Clockwise adjustments to the low-fire offset screw may also be tried. Check that gas pressure to gas valve inlet is sufficient to fire burner (see Table 4-3 for gas pressure requirements).
4. After burner lights, maintain in low fire position. At low fire, using main choke on gas valve and a combustion analyzer set O₂ level within 3-8% O₂.
5. Manually modulate the burner to high fire. Adjust the gas choke if necessary to obtain desired O₂% (5.0 - 6.0%).
6. Modulate to low fire and fine tune offset screw to obtain desired O₂ (5.0 - 6.0%).
7. Verify adjustments by modulating back and forth between low and high fire.
8. The Combustion Air Proving Switch (CAPS; see Figure 4-13) should be set at this time. After the burner is set up, dial the CAPS setting upward and restart the burner. Set just below the point the switch breaks at low fire speed.

G. Limit Controls Check

The OLC and HLC can be tested while the boiler is producing steam by adjusting the switch setting downward. A lockout should result when the switch setting is at or just below the current steam pressure.

Readjust each switch (and reset HLC) after testing. Refer to **Section 4.4 E, Operating and High Limit Controls**.

4.6-Boil-Out of a new unit

The inside of a new boiler may contain oil, grease, or other contaminants which, if not removed, could adversely affect system performance. New units should be cleaned by boil-out before use.

Recommended boil-out procedure is as follows:

1. Determine boiler water capacity (see Table 4-4). Have sufficient cleaning material on hand to complete the job.
2. When dissolving dry chemicals, slowly introduce the chemical into warm water in a suitable container. Stir constantly until the chemical is completely dissolved.

3. An over-flow pipe should be attached to one of the top boiler openings and routed to a safe point of discharge. A relief or safety valve tapping is normally used for this purpose.
4. Water relief valves and steam safety valves must be removed before adding the boilout solution to avoid contaminating the valves. Use caution when removing and reinstalling these devices.
5. All valves in the piping leading to or from the system must be closed to prevent cleaning solution from getting into the system.
6. Fill the boiler vessel with enough clean water to cover the tubes. Add the cleaning solution, then fill to the top. The water used in the initial fill should be at ambient temperature.
7. Fire the boiler intermittently at a low rate, sufficient to hold solution just at the boiling point. Boil for at least five hours. Do not produce steam pressure.
8. Allow a small amount of fresh water into the boiler. This will create a slight overflow that will carry off surface impurities.
9. Continue the boil and overflow process until the water clears. Shut the burner down.
10. Let the boiler cool to 120° F or less.
11. Remove hand-hole plates and wash the waterside surfaces thoroughly using a high pressure hose.
12. Inspect the surfaces. If they are not clean, repeat boil-out procedure.
13. After closing the handholes and reinstalling safety or relief valves, fill the boiler and fire it until the water is heated to at least 180° F to drive off any dissolved gases.

Table 4-4. CFH Boiler Water Capacity

		Boiler Horsepower				
		10-15 HP	20-25 HP	30 HP	40 HP	50-60 HP
Normal water volume	15# Steam	110 gal	137 gal	204 gal	237 gal	301 gal
	150# Steam	121 gal	149 gal	221 gal	256 gal	323 gal
Water volume flooded		140 gal	170 gal	260 gal	300 gal	386 gal

4.7-Post start-up checkout procedure

1. After verifying correct water level, fire the boiler in manual low fire.
2. Ensure the control valves will not shut off flow to the boiler.
3. Set high gas pressure switch to 50% higher than operating gas pressure at low fire. Set low gas pressure switch to 50% lower than operating gas pressure at low fire.
4. Verify the ability of the flame system to detect and respond to a loss of flame. This can be done by removing the ionization

electrode (flame rod) cable. For a successful test the boiler should shut down and the gas safety shutoff valve close with the display indicating a lockout condition. Reconnect the ionization cable to the electrode.

5. Adjust gas choke for high fire combustion to desired excess air level (5-6% O₂ recommended). Using offset screw, set low fire O₂ same as high fire O₂.
6. Check the draft on the outlet stack on each boiler, compare to acceptable limits (-.25 to +.50" W.C.) and record in start up form.
7. Switch to automatic operation and monitor flue gas to ensure consistent excess air.
8. Reassemble all panels and covers that were removed and replace any plugs that were removed to check gas pressure.
9. If boiler is equipped with a High Air Pressure Switch, check switch operation.
10. Verify with customer that softened water is being used and that a proper water treatment program is in place.
11. Provide instructions to owner and operators on operation, safety and maintenance of the equipment.



Chapter 5

Service And Periodic Maintenance

General	5-2
Blowdown	5-2
Water Column Blowdown	5-3
Fireside Cleaning Procedure/Disassembly	5-5
Electrodes and Flame Rod	5-7
Waterside Inspection/Cleaning	5-8
Safety Valve	5-8
Troubleshooting	5-9
Lay-up	5-12

5.1-GENERAL

A well-planned maintenance program will help avoid unnecessary downtime or costly repairs, and will promote safety and aid boiler inspectors. It is recommended that a boiler room log or record be maintained. Recording of daily, weekly, monthly, and yearly maintenance activities will help to obtain economical and lengthy service from the equipment.

Only trained and authorized personnel should be permitted to operate, adjust, or repair the boiler and related equipment. The boiler room should be kept free of all material and equipment not necessary to the operation of the boiler or heating system.

Be alert to unusual noises, improper gauge readings, leaks, etc. Any leaks - fuel, water, steam, exhaust gas - should be repaired promptly and with attention to safety. Preventive measures, such as regularly checking the tightness of connections, should be included in regular maintenance activities.

Insurance regulations and local laws normally require periodic inspection of the pressure vessel by an authorized inspector. Inspections are usually, though not necessarily, scheduled for periods of normal boiler downtime, such as an off season. This period can be used to accomplish maintenance, replacement, or repairs that cannot easily be done at other times.

While the inspection pertains primarily to the waterside and fireside surfaces of the pressure vessel, the inspection period provides operators with an opportunity for a detailed check of all boiler components including piping, valves, gaskets, refractory, etc. Comprehensive cleaning, spot painting, and replacement of expendable items should be planned for and taken care of during this time.

Cleaver-Brooks recommends common replacement parts be on hand during inspection and maintenance. Please refer to the Recommended Spare Parts List in the Parts section of this manual.

5.2-BLOWDOWN

Water treatment alone can never completely eliminate unwanted solids from boiler feedwater. In order to keep these substances to a minimum, blowdown should be performed at regular intervals.

Bottom blowdown fittings include a quick-opening valve (nearest the boiler) and a slow-opening valve. The quick-opening valve is opened first and closed last, with blowdown controlled using the slow-opening or downstream valve.

NOTE: To insure proper operation, use only Cleaver-Brooks parts for replacement.

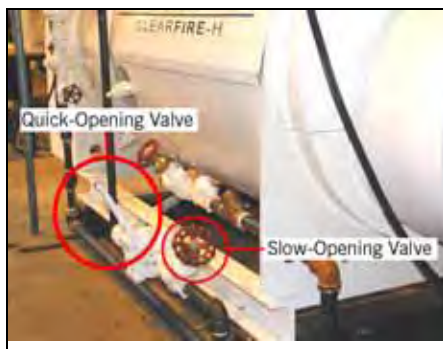


Figure 5-1 Bottom blowdown piping

Manual Blowdown Procedure

Blowdown is most effective when the boiler is under a light load, and when the water level is at the Normal Operating Water Level.

Be sure the blowdown piping is in proper operating condition. Waste should be piped to a point of safe discharge.

1. Open the quick-opening valve.
2. Crack the second or downstream valve slightly to allow the lines to warm, then continue opening slowly to its fully open position.

The duration of each blowdown should be determined by water analysis. A reduction of water level in the gauge glass by about 1/2" can often serve as a rough guide, but should not replace water analysis procedures.

3. When blowdown is complete, close the downstream (slow-opening) valve first, as quickly as possible. Then close the quick-opening valve. Finally, crack the downstream valve slightly, then close it tightly.

It is generally recommended that bottom blowdown be performed at least once in every eight-hour period. Actual frequency may vary depending on water conditions and boiler operating conditions. Consult the appropriate water treatment personnel regarding blowdown scheduling.

**Caution**

During blowdown, do not pump the lever action valve open and closed. Equipment damage may result.

Under no circumstances should a blow-down valve be left open. Never leave the boiler unattended during blowdown.

5.3-WATER COLUMN BLOWDOWN

Free flow of water through the water column and gauge glass is essential to obtaining accurate boiler water level indication and control. It is recommended that the water column and gauge glass be blown down every shift to remove accumulated solids. Regular blowdown of the water column will help maintain the integrity of the water level probes and will help to ensure trouble-free operation of the boiler. See **Figure 5-2** for procedure.

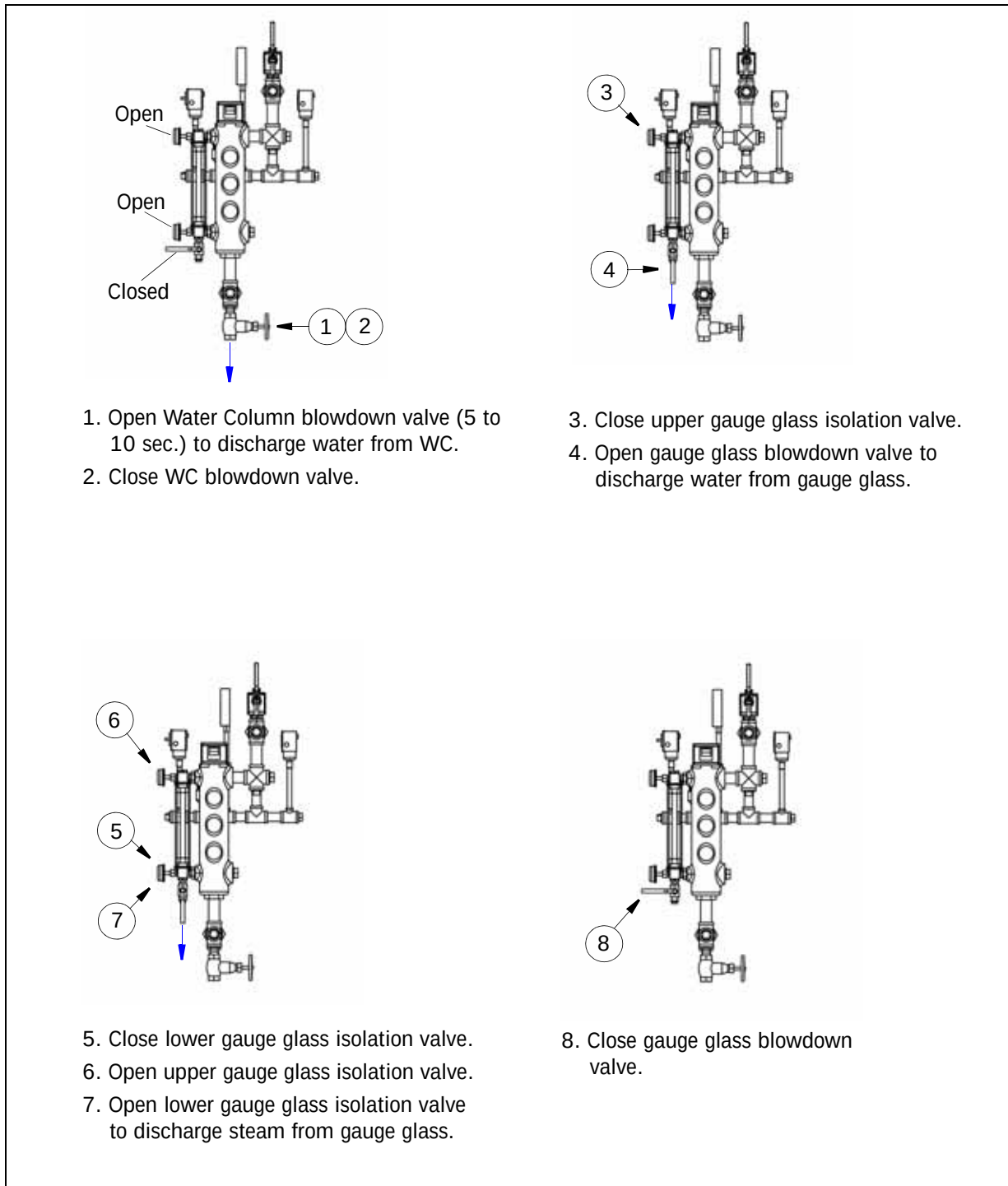


Figure 5-2 Water Column and Gauge Glass Blowdown

Periodic replacement of the water gauge glass should be part of a regular maintenance program. A broken or discolored glass should be replaced at once.

Use a proper size rubber packing. Do not use loose packing, which could be forced below the glass and possibly plug the valve opening.

Close the valves when replacing the glass. Slip a packing nut, packing washer, and packing ring onto each end of the glass. Insert one end of the glass into the upper gauge valve body far enough to allow the lower end to be dropped into the lower body. Slide the packing nuts onto each valve and tighten.

It is recommended that the boiler is off and cool when the glass is replaced. However, if the glass is replaced while the boiler is in service, open the blowdown valve and slowly bring the glass up to temperature by opening the gauge valves slightly. After the glass is warmed up, close the blowdown valve and open the gauge valves completely.



Figure 5-3 Water column gauge glass

5.4-FIRESIDE CLEANING PROCEDURE/ DISASSEMBLY

1. Locate the manual shutoff gas valve for the gas supply to the burner and turn it to the closed or shut position.
2. Disconnect all electrical power to the control panel at the primary switch box or breaker box supplying power to the boiler.
3. Remove the front casing enclosure and set aside.
4. Disconnect power and signal harnesses from blower.
5. Disconnect the ignition cables and flame sensor cable from the electrodes.
- 6 a. If using room combustion air, remove air filter. Inspect and clean as necessary.



Figure 5-4 Front burner access panel removed

NOTE: Do not discard the air filter. It may be cleaned and re-used. Contact Cleaver-Brooks for cleaning kits.

- b. Remove the air combustion piping at the inlet to the fan air intake, if supplied with direct vent combustion.
7. Disconnect the burner gas train from the gas supply piping.
8. Unscrew the hold down bolts securing the burner door to the pressure vessel.
9. The burner door, burner head, blower motor and assembly can now be swung open providing access to the burner head and combustion chamber.

With the burner head assembly swung open, the burner parts and combustion chamber can be inspected.

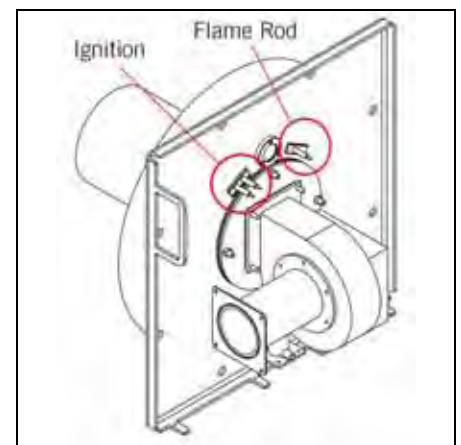


Figure 5-5 Electrode connections



Figure 5-6 Burner assembly open

- A. Check ignition and ionization electrodes for deposits and proper gap. Clean or replace as required. Refer to Fig. 5-9 and Fig. 5-10
- B. Check the burner canister for any damage, burn marks, or perforations. Replace if damaged. If the canister is in good condition, clean out any dirt or dust with a vacuum cleaner or low-pressure air hose.
- C. Inspect door refractory and patch any cracks.
- D. Inspect the pressure vessel and combustion chamber area for any damage or residue. If dirt or contaminants are found, it is recommended that the tube sheet and tubes be washed with a high-pressure power washer.
- E. Replace the burner door gasket. New gasket should be properly situated in door gasket seat.*



Figure 5-7 Burner door gasket

If any adverse conditions are observed during operation or inspection, contact your authorized Cleaver-Brooks service representative.

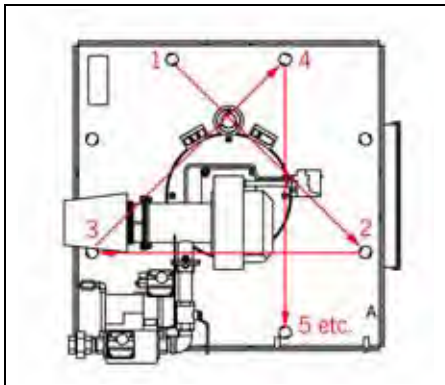


Figure 5-8 Fastening burner door

When inspection and servicing are completed, reassemble the burner in reverse order. When re-fastening burner door:

- 1) Coat bolt threads with anti-seize compound.
- 2) Tighten bolts gradually in a diagonal pattern to ensure a secure fit (see Figure 5-7). It may take several cycles of the pattern to reach uniform tightness.
- 3) Torque bolts to 11 ft-lbs (132 in-lbs).*

Ensure that all connections are tight and secure before reconnecting power or fuel supply. After turning the gas supply on, reset the gas pressure switches.

NOTE: A gas valve leak test is recommended during fireside inspection. See Appendix A for leak test procedure.

***NOTE:** Re-torque door bolts 7-10 days after replacing burner door gasket.

5.5-ELECTRODES AND FLAME ROD

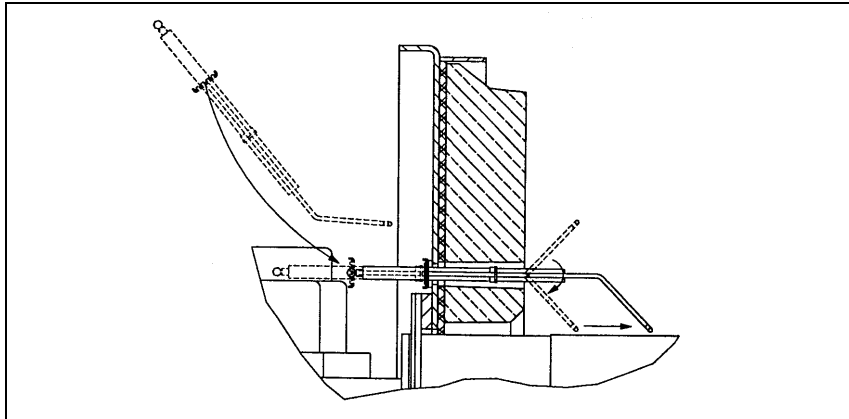


Figure 5-9 Electrode Setup

The ignition and ionization electrodes should be checked on an annual basis or as needed if ignition problems are encountered. Replacement should be accomplished as shown in **Figure 5-9** with the electrode turned toward the burner mantle/canister after it is inserted into the burner head.

Caution

The dimensions on both the Ignition Electrodes and the Flame Rod are not easily adjustable. Bending the rods can cause damage to the insulating material. In addition, a bent electrode will have a tendency to return to its original shape when heated. If the electrodes are out of specification, replacement is generally recommended.

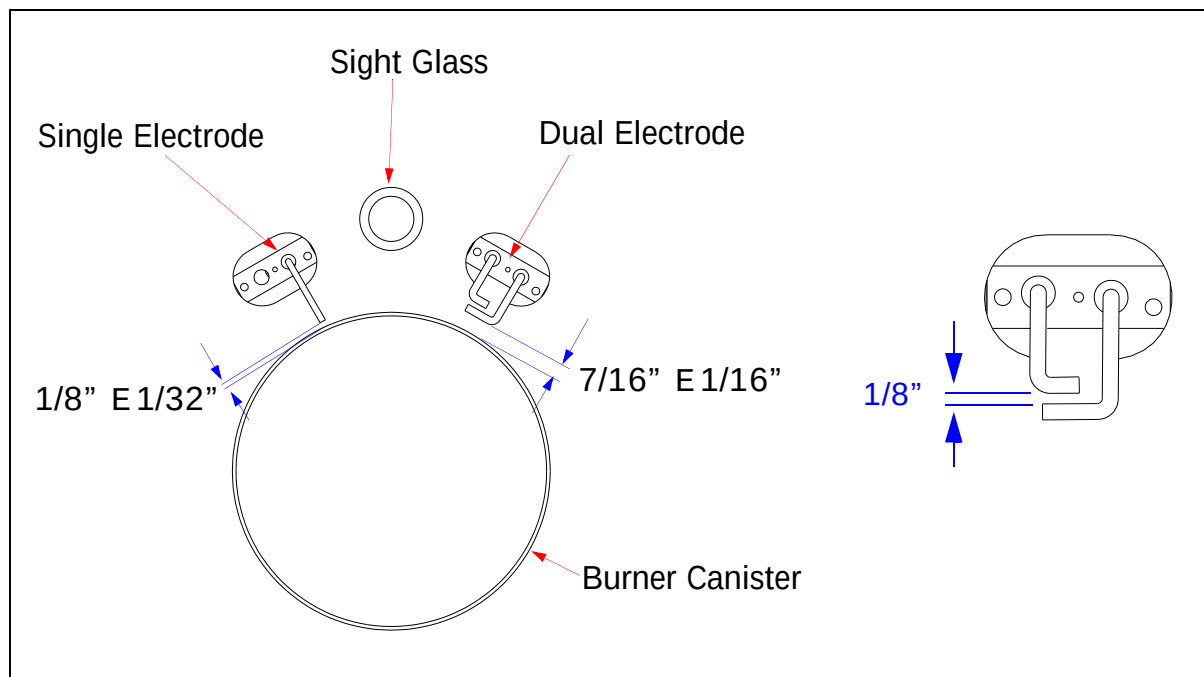


Figure 5-10

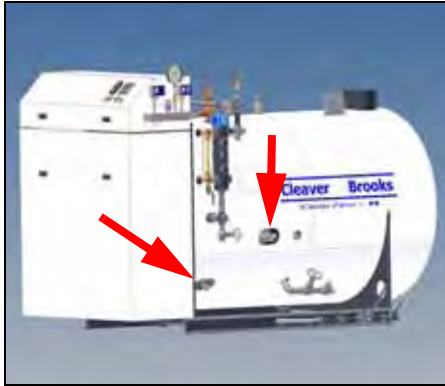


Figure 5-11 Handholes



Important

Clean probes are essential to proper boiler operation. Always ensure that probes remain free of debris and buildup.

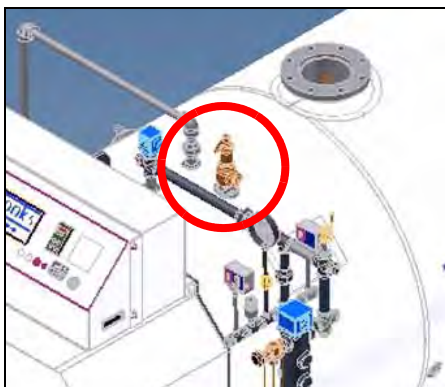


Figure 5-12 Safety Valve

5.6-WATERSIDE INSPECTION/CLEANING

Waterside inspection frequency may depend upon the local jurisdiction and inspector but it is recommended that after the first year of operation, a waterside inspection take place.

To inspect the boiler on the waterside, first shut off the electric power to the burner. Close all waterside stop and shutoff valves. Close the manual gas shutoff valve. After allowing the boiler to cool, open the bottom blowdown valve, crack the air vent valve, and drain the boiler. While the boiler is draining, note the condition of the water.

When the water has drained from the boiler, remove the handhole covers and examine the waterside surfaces. Use a good flashlight and, where necessary, a swivel mirror with an extension. Discuss any scale, sludge or other buildup on the surfaces with the water treatment company or technician.

Remove the equalizing piping plugs, remove all probes, and inspect. Clean as necessary, being sure to remove any debris or blockages.

If a waterside sludge buildup is noticed, flush the waterside and drain. Again, consult with the water treatment company or technician on cleaning. After inspection, install new gaskets, close the handholes, replace probes, tighten plugs, and allow water to fill the boiler while keeping the air vent valve open. Close valve before placing boiler back into operation.

5.7-SAFETY VALVE

The safety valve is an important safety device and deserves attention accordingly. Follow the recommendations of your boiler inspector regarding valve inspection and testing. The frequency of testing, either by use of the lifting lever or by raising the steam pressure, should be based on the recommendation of your boiler inspector and/or the valve manufacturer, and should be in accordance with sections VI and VII of the ASME Boiler and Pressure Vessel Code.

Avoid excessive operation of the safety valve; a valve that is opened too frequently can develop leaks. Safety valves should be operated only often enough to assure that they are in good working order. When a pop test is required, raise the operating pressure to the set pressure of the valve, allowing it to open and reseat as it would in normal service.

Do not hand operate the valve with less than 75% of the stamped set pressure on the underside of the disc. When hand operating, be sure to hold the valve in an open position long enough to purge accumulated foreign material from the seat area and then allow the valve to snap shut.

5.8-TROUBLESHOOTING

CB90 Flame Safety Lockout Codes

The CB90 flame safety includes a diagnostic feature to alert operators to conditions causing a lockout. When using the optional display, the LOCKOUT HISTORY sub-menu shows the last six lockouts, along with the burner cycle and burner hour when each lockout occurred. Pressing the MODE key shows the number and description of the most recent lockout (see example below). The SCRL key shows the burner hour, followed by the burner cycle when the lockout occurred. Pressing SCRL again advances through the lockout list, repeating the above sequence. The MODE key returns to the main menu.

Example: while in the LOCKOUT HISTORY submenu, use the SCRL and MODE buttons as follows:

Press	Example Screen Display	Description
MODE	LO #127 TFI FLAME FAIL	The most recent lockout condition. This is the 127th lockout of the system. Lockout occurred during TFI.
SCRL	LO #127 TFI @ BNR HOURS 136	Lockout #127 occurred after 136 hours of burner operation.
SCRL	LO #127 TFI @ BNR CYCLE 744	Lockout #127 occurred at burner cycle 744
SCRL	LO #126 PURGE AIR FLOW OPEN	The second latest lockout condition. History indicates the lockout occurred during purge.
MODE	AUTO 45 FLAME SIGNAL	Screen has returned to the normal run message.

To view lockout codes when not using the optional display, remove the electrical panel cover and note the LED configuration on the CB90 unit (see table below).

MSG		DESCRIPTION	OP CTRL	AIRFLOW INTLCK	PTFI	FLAME	ALARM
DEC	HEX						
6	6	Lockout line frequency noise detected	●	○	○	●	*
7	7	Lockout Flame Fail - TFI	○	●	●	●	*
15	0F	Lockout fault unknown	●	●	●	●	*
16	10	Lockout amplifier high count fail	○	○	○	○	*
19	13	Lockout flame fail - MTFI	○	○	●	●	*
20	14	Lockout false flame - STANDBY	○	●	○	○	*
21	15	Lockout intrlck open	●	●	●	○	*
22	16	Lockout intrlck closed	○	●	●	○	*
24	18	Lockout chassis opto	●	●	○	●	*
37	25	Lockout flame fail - AUTO	○	●	○	●	*
39	27	Lockout fuel valve state change	○	○	○	●	*
54	36	Lockout check chassis	○	○	○	●	*
55	37	Lockout check programmer	○	○	●	○	*
56	38	Lockout check amplifier	●	○	○	○	*
58	3A	Lockout amplifier auto check fail	●	○	●	○	*
59	3B	Lockout check BLOWN FUSE	●	○	●	●	*
76	4C	Lockout check scanner	●	●	○	○	*

○ = NOT LIGHTED

● = LIGHTED

* = FLASHING



Figure 5-13 CB90 LEDs

RWF40 Faults

Alarm/lockout conditions are indicated on the RWF40 display by flashing numbers. The table below shows the controller error codes.

Display	Description	Cause/Controller Behavior/ Remedy
	Actual value display (red) shows <1999> flashing. Setpoint display shows the setpoint.	Overrange or underrange on analog input 1. Actual value is not measured. Controller initiates lockout. The limit comparator responds to analog input 1 according to configuration C113. Check electrical connections for open-circuit of sensor.
	When analog input 3 is configured for outside temperature (C111) and the measured value is called up, the actual value display (red) shows <1999> flashing.	Overrange or underrange on analog input 3. Outside temperature is not measured. Weather-dependent setpoint is inactive. Check electrical connections for open-circuit of sensors.
	When analog input 2 is configured (C111) and the measured value is called up, the actual value display (red) shows <1999> flashing.	Overrange or underrange on analog input 2. Setpoint shift is not measured. Controller initiates lockout. Check electrical connections for open-circuit of sensor.
	Actual value display (red) shows <XXXXXX>. Setpoint display (green) shows <1999> flashing.	Overrange or underrange on analog input 2. Setpoint shift is not measured. Controller initiates lockout. Check electrical connections for open-circuit of sensor.

5.9-LAY-UP

If the boiler will be out of use for an extended period, precautions must be taken to protect fireside and waterside surfaces from deterioration due to corrosion.

At the start of lay-up, thoroughly clean the fireside by removing any soot or other products of combustion from the tubes, tube sheets, and other fireside surfaces. After brushing all surfaces clean, sweep away or vacuum any residue. The fireside may be flushed with water; however, all surfaces should be completely dried before lay-up.

Dry Lay-up

Dry lay-up is generally used when the boiler will be out of service for a lengthy time period, or where the boiler might be subject to freezing temperatures. The boiler must be thoroughly dried before dry storage, as any moisture could cause corrosion. Both fireside and waterside surfaces must be cleaned of all scale, deposits, soot, etc. A desiccant such as quick lime or silica gel should be placed in suitable containers inside the boiler vessel.

Wet Lay-up

Wet storage is generally used when a boiler may be needed on short notice or in cases where dry storage is not practical. Before wet storage the vessel should be drained, thoroughly cleaned, and refilled to overflowing with treated water. If deaerated water is not available, the unit should be fired to boil the water for a short period of time.

Whichever method of lay-up is used, a periodic re-check of fireside and waterside conditions is recommended during lay-up.



Chapter 6

ClearFire-H Parts

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1. High Level Assembly 10 HP 15# St.

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	270-0332-000	PRESSURE VESSEL ASSEMBLY (270C0332)
2	1	430-01618-000	BURNER ASSEMBLY C/W GAS TRAIN (430001618)
3	1	507-008195-000	Control Piping (507C08195)
4	1	940-03073-000	SAFETY RELIEF VALVE (146C00015)
5	1	465-02605-000	INSULATION AND LAGGING ASSEMBLY (465C02605)
6	1	285-03333-000	CONTROL PANEL (285C03333)
7	2	118-03637-000	Label, CH Boiler Casing (118B03637)
8	1	118-03638-000	Label, CH Boiler Casing (118B03638)
9	1	118-03634-000	Data Plate, CH Boilers (118A03634)
10	1	507-008084-000	FEEDWATER PIPING (507C08084)
11	1	507-07951-000	BOTTOM BLOWDOWN PIPING (507C07951)
12	1	507-08115-000	SURFACE BLOWOFF PIPING (507C08115)
13	1	157-02363-000	SURFACE BLOWOFF DIP TUBE (157C02363)
14	8	952-00392-000	WASHER, FENDER, 3/8" BOLT
15	8	868-00450-000	CAPSCREW, HEX HD, 3/8"-16 UNC X 4" LG.
16	2	952-00111-000	WASHER PLATED
17	1	914-00093-000	RETAINER RING, TRU/ARC, 5" SHAFT
18	1	056-00297-000	PIN, HINGE, FRONT DOOR (056C00297)
19	6	860-00596-000	SETSCREW, FLAT POINT, 3/8"-16 UNC X .5" LG.
20	1	008-03600-000	BRACKET, GAS TRAIN PIPING (008C03600)
21	2	841-01122-000	U-BOLT WITH NUTS (1 1/4")
22	1	118-02569-000	LABEL, MADE IN CANADA
23	1	118-02096-000	NAMEPLATE INSPECTION (118A02096)
24	1	858-01304-000	PLUG, 5" NPT
25	1	118-03666-000	NAME PLATE, DRAIN PLUG (118A03666)
26	1	849-01031-000	FLANGE THREADED, 150#, 4" F.F.
27	1	008-03643-000	BRACKET, BLOWDOWN PIPING (008B03643)
28	6'	938-01134-000	COPPER TUBING, 3/8" X 8' LG.
29	1	118-00331-000	NAMEPLATE, UL GAS FIRED BOILER (118A00331)

Mounted and piped feedwater tank - 656C09154 (future)

Sealed combustion kit - (880C02042)

Economizer installation - (611C00148)

Notes:

Ensure door is centered over furnace.

Adjust item 19 as required to align door.

Apply grease to pin prior to installation.

DETAIL B

DETAIL A

Add extra item 16's as required.

For Economizer Installation
Remove Smoke Box Cover.

Smoke Box Drain Plug & Tag.

Front Cover Removed For Clarity

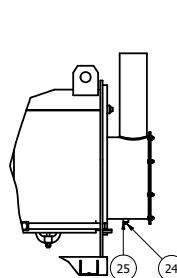
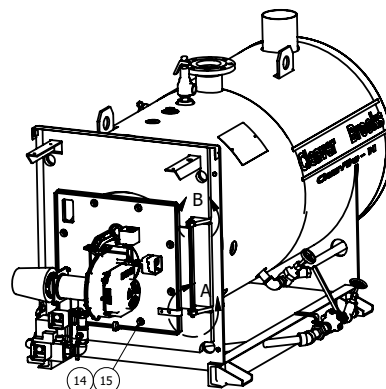
12" REF.

31" REF.

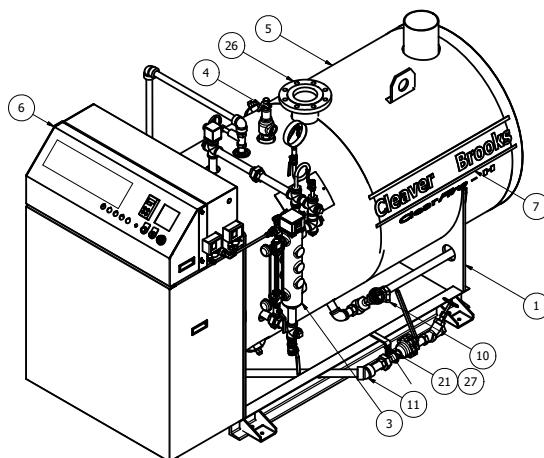
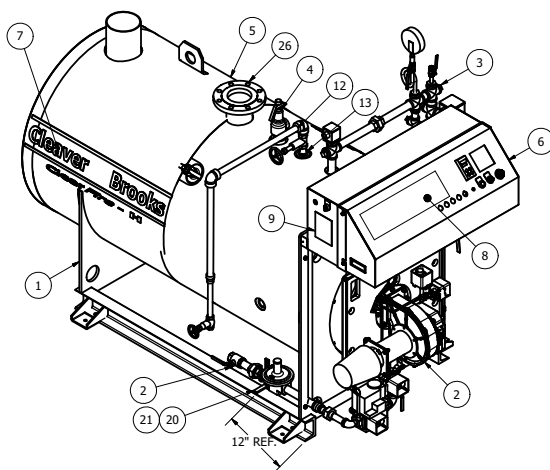
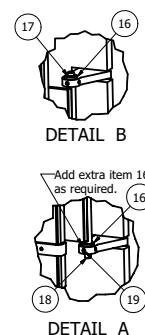
2. High Level Assembly 15 HP 15# St.

Parts List

ITEM	QTY	PART NUMBER	DESCRIPTION	
1	1	270C03337	Pressure Vessel Assembly	
2	1	429D01586	Burner Assembly C/W Gas Train	
3	1	507C08185	Control Piping (As Shown)	
4	1	940-5073	Safety Valve	
5	1	465C02605	Insulation and Lagging Assembly	
6	1	283C03333	Control Panel	
7	2	118B03637	Label, CFH Boiler Casing	
8	1	118B03638	Label, CFH Boiler Panel	
9	1	118A03634	Data Plate, CFH Boilers	
10	1	507C08084	Mounted Feedwater Piping	Optional
11	1	507C07951	Bottom Blowdown Piping	Optional
12	1	507C08115	Surface Blowoff Piping	Optional
13	1	157C02295	Surface Blowoff Dip Tube	Optional
14	8	952-00392	Washer, Fender, 3/8" Bolt	
15	8	868-00450	Capscrew, Hex.Hd. 3/8"-16 UNC x 4.0" Lg.	
16	2	952-00111	Washer Plated	
17	1	914-00093	Retainer Ring, TruArc, .5" Shaft	
18	1	056C00297	Pin, Hinge, Front Door	
19	6	860-00596	Setscrew, Flat Pnt, 3/8"-16 UNC x .5"Lg.	
20	1	008-03600	Bracket, Gas Train	
21	2	841-01122	U-Bolt with Nuts	
22	1	118-02569	Label, Made in Canada	
23	1	118A00296	Nameplate Inspection	
24	1	858-01304	Plug, .5" NPT	
25	1	118A03666	Name Plate, Drain Plug	
26	1	849-01031	Flange Threaded 150#, 4" F.F.	
27	1	008-03643	Bracket, Blowdown Piping	
28	6'	939-01134	Bulk Copper Tubing	

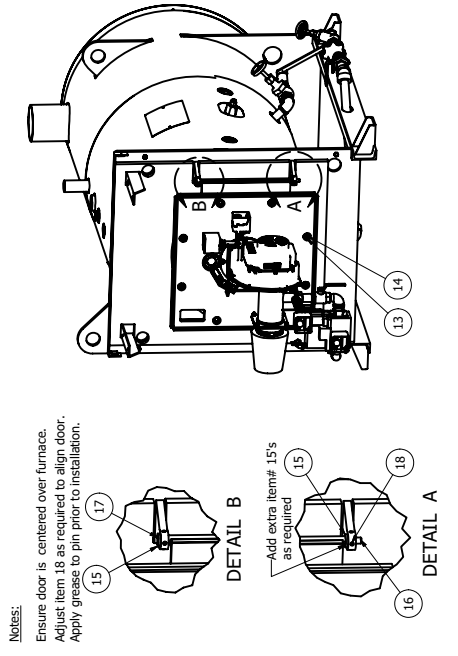


Smoke Box Drain Plug & Tag.

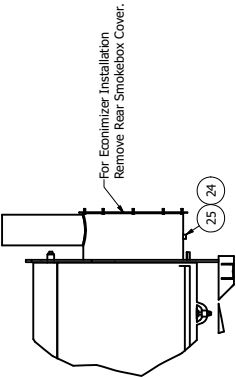


146 00553	ALL MATERIAL SIZES ON BILL OF MATERIAL ARE FOR REFERENCE ONLY. DRAWING DIMENSIONS MUST BE FOLLOWED. TOLERANCE, UNLESS OTHERWISE SPECIFIED:		DESIGN BY: AA	CLEAVER BROOKS The power of commitment. HIGH LEVEL ASSEMBLY 15HP 15# ST. CFH BOILER	REV 01
	FRACTIONAL: ±		CHECKED BY: CP		
	DECIMAL: ±		DATE: 10/19/2007		
	HOLE LOCATIONS: ±		SCALE:		
SIZE	SHT 1 OF 1		N.T.S.	DRWG. NO.	

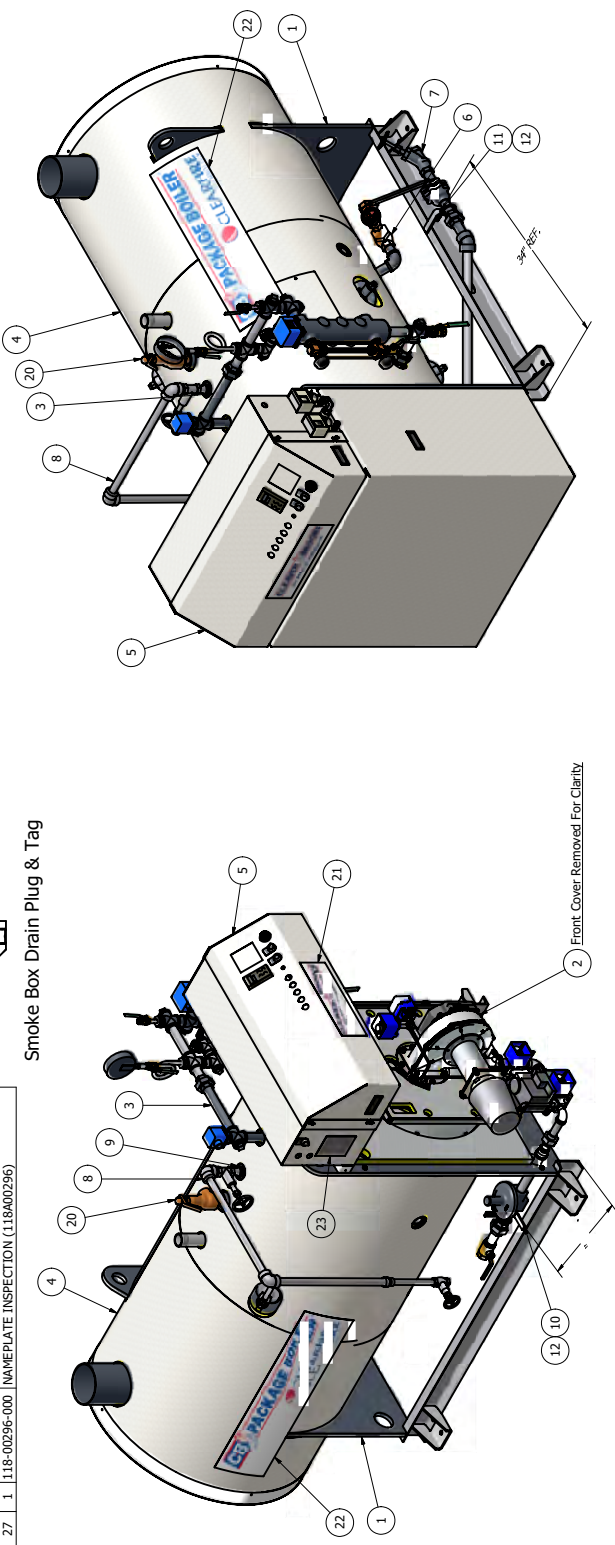
3. High Level Assembly 15 HP 150# St.



Parts List		
ITEM	QTY	DESCRIPTION
1	1	270-03271-000 PRESSURE VESSEL ASSEMBLY (270C03271)
2	1	429-01586-000 BURNER ASSEMBLY C/W GAS TRAIN (429D01586)
3	1	507-07949-000 CONTROL PIPING (507C07949)
4	1	465-02544-000 INSULATION & LAGGING ASSEMBLY (465C02544)
5	1	283-03333-000 CONTROL PANEL (283C03333)
6	1	507-06884-000 FEEDWATER PIPING (507C06884)
7	1	507-07951-000 BOTTOM BLOWDOWN PIPING (507C07951)
8	1	507-08115-000 SURFACE BLOWDOWN PIPING (507C08115)
9	1	157-02357-000 SURFACE BLOWOFF DIP TUBE (157C02357)
10	1	008-03600-000 BRACKET, GAS TRAIN PIPING (008C03600)
11	1	008-03643-000 BRACKET, BLOWDOWN PIPING (008C03643)
12	2	841-01122-000 U-BOLT WITH NUTS (1 1/4")
13	8	952-00392-000 WASHER, FENDER, 3/8" BOLT
14	8	868-00450-000 CAPSCREW, HEX HD, 3/8"-16 UNC X 4" LG.
15	2	952-00111-000 WASHER PLATED
16	1	056-00297-000 PIN, HINGE, FRONT DOOR (056C00297)
17	1	914-00093-000 RETAINER RING, TRU/ARC, .5" SHAFT
18	6	860-00996-000 SETSCREW, FLAT POINT, 3/8"-16 UNC X .5" LG.
19	1	939-01134-000 COPPER TUBING, 3/8" X 6' LG.
20	1	940-05602-000 SAFETY RELIEF VALVE (146C00015)
21	1	118-03638-000 LABEL, CFH BOILER PANEL (118B03638)
22	2	118-03637-000 LABEL, CFH BOILER CASING (118B03637)
23	1	118-03634-000 DATA PLATE, CFH BOILERS (118A03634)
24	1	858-01304-000 PLUG, .5" NPT
25	1	118-03666-000 NAMEPLATE, DRAIN PLUG (118A03666)
26	1	118-02569-000 LABEL, MADE IN CANADA
27	1	118-00296-000 NAMEPLATE INSPECTION (118A00296)



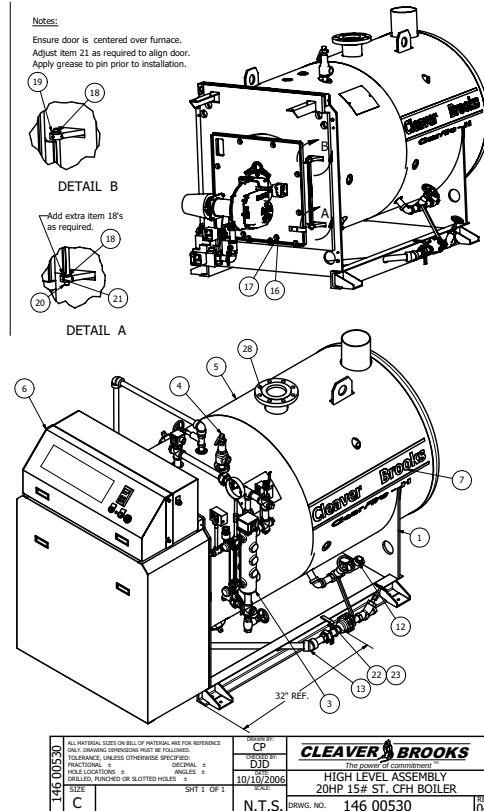
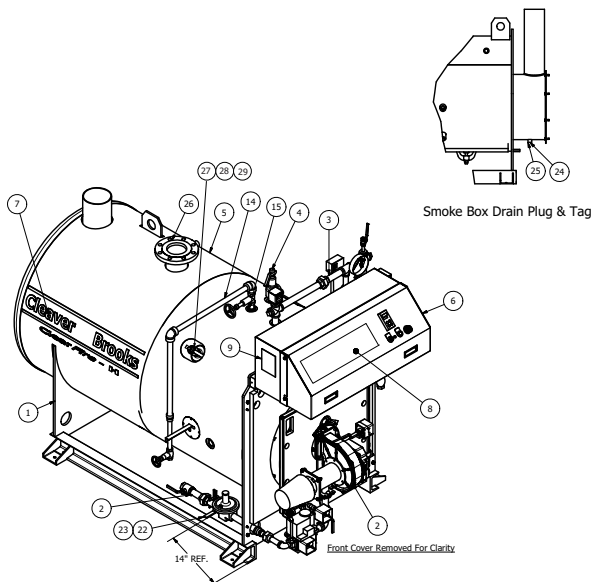
Smoke Box Drain Plug & Tag



4. High Level Assembly 20-25 HP

ITEM	QTY	20 HP 15# P/N	20 HP 150# P/N	25 HP 15# P/N	25 HP 150# P/N.	DESCRIPTION	
1	1	270C03222	270C03315	270C03222	270C03312	Pressure Vessel Assembly	
2	1	146C00537	146C00537	146C00527	146C00527	Burner Assembly	
3	1	507C07931	507C08100	507C07931	507C08100	Control Piping	
4	1	940-05073	940-05602	940-05072	940-05500	Safety Valve	
5	1	465C02538	465C02582	465C02538	465C02577	Insulation And Lagging Assembly	
6	1	283C03333	283C03333	283C03333	283C03333	Control Panel	
7	2	118B03637	118B03637	118B03637	118B03637	Label, CFH Boiler Casing	
8	1	118B03638	118B03638	118B03638	118B03638	Label, CFH Boiler Panel	
9	1	118A03634	118A03634	118A03634	118A03634	Data Plate, CFH Boilers	
10	1	832-02120	832-02120	832-02120	832-02120	Ignition Cable (not shown)	
11	1	832-02121	832-02121	832-02121	832-02121	Ignition Cable Ground (not shown)	
12	1	507C08084	507C08084	507C08084	507C08084	Mounted Feedwater Piping	Optional
13	1	507C07941	507C07941	507C07941	507C07941	Bottom Blowdown Piping	Optional
14	1	507C08115	507C08115	507C08115	507C08115	Surface Blowoff Piping	Optional
15	1	157C02295	157C02295	157C02295	157C02295	Surface Blowoff Dip Tube	Optional
16	8	952-00392	952-00392	952-00392	952-00392	Washer, Fender, 3/8" Bolt	
17	8	868-00450	868-00450	868-00450	868-00450	Capscrew, Hex. Hd. 3/8"-16 UNC x 4" Lg.	
18	2	952-00111	952-00111	952-00111	952-00111	Washer, Plated	
19	1	914-00093	914-00093	914-00093	914-00093	Retainer Ring, TruArc, .5" Shaft	
20	1	056C00297	056C00297	056C00297	056C00297	Pin, Hinge, Front Door	
21	6	860-00596	860-00596	860-00596	860-00596	Setscrew, Flat Pnt, 3/8"-16 UNC x .5" Lg.	
22	2	008C03600	008B03600	008B03600	008C03600	Bracket, Gas Train, Blowdown Piping	
23	2	841-01122	841-01122	841-01122	841-01122	U-Bolt With Nuts	
24	1	858-00091	858-00091	858-00091	858-00091	Plug, .5" NPT	
25	1	118A03666	118A03666	118A03666	118A03666	Name Plate, Drain Plugs	
26	1	849-01031		849-01031		Flange	
27,28,29		See Table				Handhole Cover Assembly	

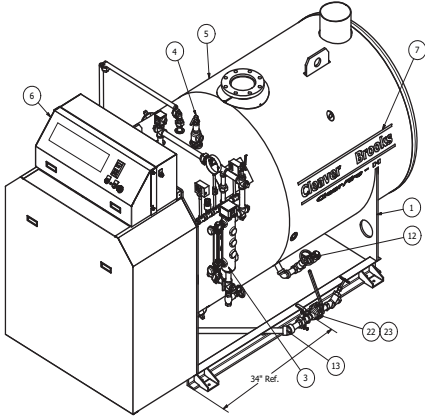
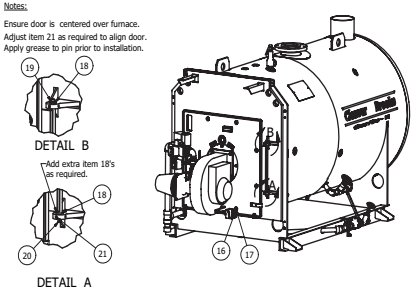
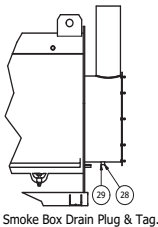
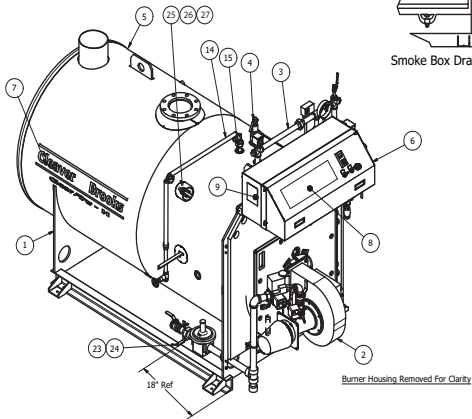
Handhole Items				
ITEM	QTY	PART NUMBER	DESCRIPTION	
27	3	317-00057	HANDHOLE COVER, STUD, AND WASHER ASSEMBLY	
28	3	953-00048	HANDHOLE YOKE, 2 PRONG, FORGED	
29	3	853-00934	HANDHOLE GASKET, 2 3/4" x 3 1/2"	



5. High Level Assembly 30-40 HP

ITEM	QTY	30 HP 15# ST. PART NUMBER	30 HP 150# ST. PART NUMBER	40 HP 15# ST. PART NUMBER	40 HP 150# ST. PART NUMBER	DESCRIPTION	
1	1	270C03299	270C03287	270C03297	270C03289	Pressure Vessel Assembly	
2	1	032C02636	032C02636	032C02636	032C02636	Gasket, Rear Outlet Box	
3	1	059C07804	059C07804	059C07804	059C07804	Rear Box Outlet Cover	
4	1	146C00528	146C00528	146C00509	146C00509	Front Door Assembly	
5	1	507C07954	507C08098	507C07954	507C08098	Control Piping	
6	1	940-05072	940-05500	940-04993	940-05500	Safety Valve	
7	1	465C02550	465C02575	465C02558	465C02576	Insulation And Lagging Assembly	
8	1	283C03333	283C03333	283C03333	283C03333	Control Panel	
9	2	118B03637	118B03637	118B03637	118B03637	Label, CFH Boiler Casing	
10	1	118B03638	118B03638	118B03638	118B03638	Label, CFH Boiler Panel	
11	1	118A03634	118A03634	118A03634	118A03634	Data Plate, CFH Boilers	
12	1	832-02120	832-02120	832-02120	832-02120	Ignition Cable (not shown)	
13	1	832-02121	832-02121	832-02121	832-02121	Ignition Cable Ground (not shown)	
14	1	507C08084	507C08084	507C08084	507C08084	Mounted Feedwater Piping	Optional
15	1	507C07956	507C07956	507C07956	507C07956	Bottom Blowdown Piping	Optional
16	8	952-00392	952-00392	952-00392	952-00392	Washer, Fender, 3/8" Bolt	
17	8	868-00450	868-00450	868-00450	868-00450	Capscrew, Hex. Hd. 3/8"-16 UNC x 4" Lg.	
18	2	952-00111	952-00111	952-00111	952-00111	Washer. Plated	
19	1	914-00093	914-00093	914-00093	914-00093	Retainer Ring, TruArc, .5" Shaft	
20	1	056C00297	056C00297	056C00297	056C00297	Pin, Hinge, Front Door	
21	6	860-00596	860-00596	860-00596	860-00596	Setscrew, Flat Pnt, 3/8"-16 UNC x .5" Lg.	
22	1	008C03600	008C03600	008C03600	008C03600	Bracket, Blowdown Piping	
23	1	841-01122	841-01122	841-01122	841-01122	U-Bolt With Nuts	
24	1	008C03606	008C03606	008C03606	008C03606	Bracket, Gas Train Piping	
25,26,27	See Table					Handhole Cover Assembly	

Handhole Items				
ITEM	QTY	150#	PART NUMBER	DESCRIPTION
25	3	4	317-00057	HANDHOLE COVER, STUD, AND WASHER ASSEMBLY
26	3	4	953-00048	HANDHOLE YOKE, 2 PRONG, FORGED
27	3	4	853-00934	HANDHOLE GASKET, 2 3/4" x 3 1/2"

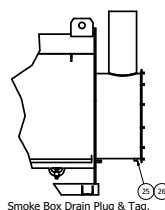


146C00529		CP	CLEAVER BROOKS
DJD		10/4/2006	146 00529
C		N.T.S.	146 00529

6. High Level Assembly 50-60 HP 15# St.

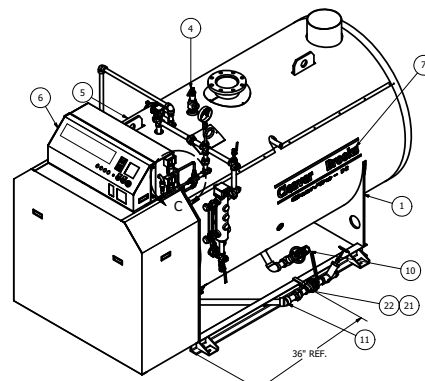
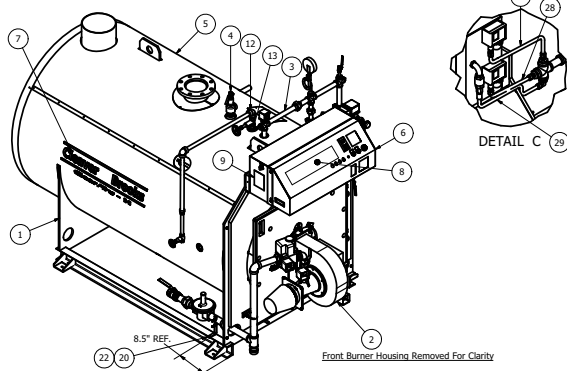
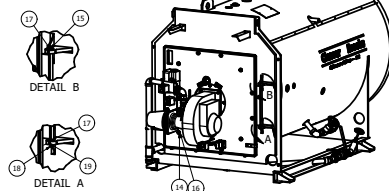
ITEM	QTY	50-60 HP 15# P/N	DESCRIPTION	
1	1	270C03336	Pressure Vessel Assembly	
2	1	429-01591	Burner Assembly	
3	1	507C08183	Control Piping	
4	1	See Table	Safety Valve	
5	1	465C02606	Insulation And Lagging Assembly	
6	1	283C03333	Control Panel	
7	2	118B03637	Label, CFH Boiler Casing	
8	1	118B03638	Label, CFH Boiler Panel	
9	1	118A03634	Data Plate, CFH Boilers	
10	1	507C08107	Mounted Feedwater Piping	Optional
11	1	507C08105	Bottom Blowdown Piping	Optional
12	1	507C08115	Surface Blowoff Piping	Optional
13	1	157C02295	Surface Blowoff Dip Tube	Optional
14	12	868-00450	Capscrew, Hex. Hd. 3/8"-16 UNC x 4" Lg.	
15	1	914-00093	Retainer Ring, TruArc, .5" Shaft	
16	12	952-00392	Washer, Fender, 3/8" Bolt	
17	2	952-00111	Washer, Plated	
18	1	056C00297	Pin, Hinge, Front Door	
19	6	860-00596	Setscrew, Flat Pnt, 3/8"-16 UNC x .5" Lg.	
20	1	008B03606	Bracket, Gas Train Piping	
21	1	008B03643	Bracket, Blowdown Piping	
22	2	841-01122	U-Bolt With Nuts	
23	1	118-02569	Label	
24	1	118A00296	Name Plate	
25	1	858-00091	Plug	
26	1	118A03666	Name Plate	
27	1	090-02027	Operating Limit Control Tubing	
28	1	090-02028	High Limit Control Tubing	
29	1	090-02026	Pressure Transmitter Tubing	

SAFETY VALVE	
50 HP	940-4993
60 HP	940-5297



Smoke Box Drain Plug & Tag.

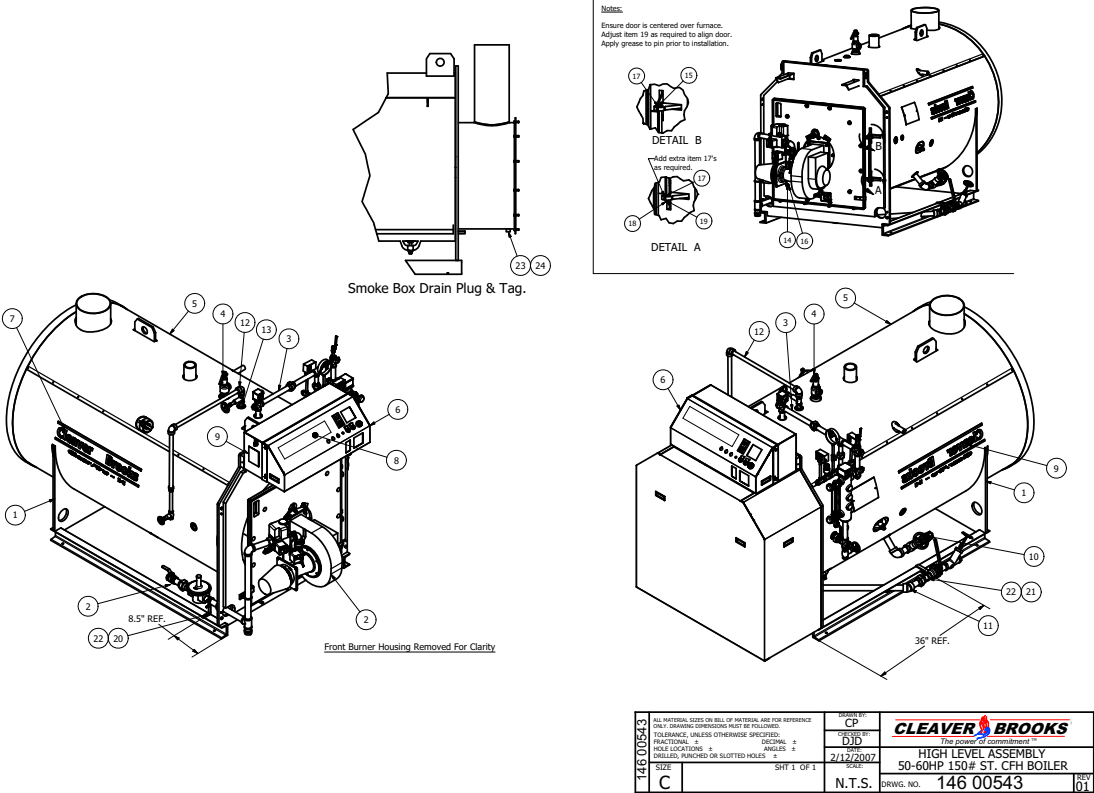
Notes:
 Ensure door is centered over furnace.
 Adjust item 19 as required to align door.
 Apply grease to pin prior to installation.



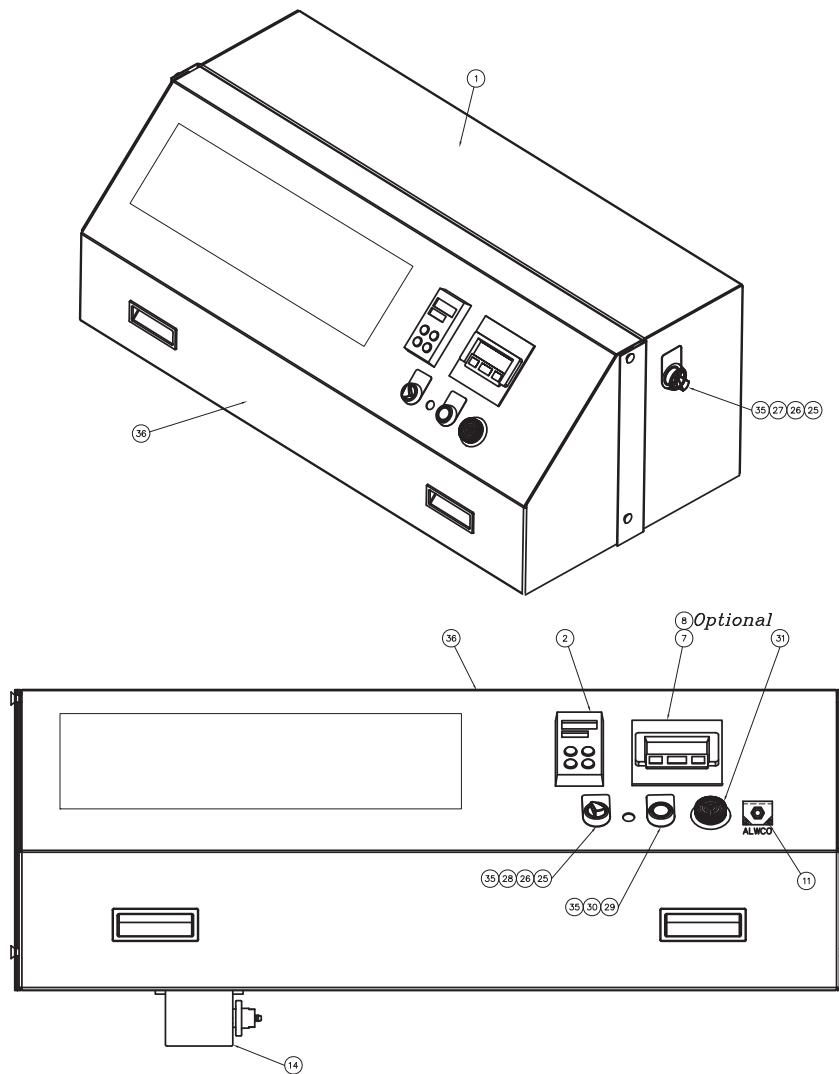
746 00554	ALL DIMENSIONS ON BELL OF MATERIAL ARE FOR REFERENCE ONLY DRAWING DIMENSIONS MUST BE FOLLOWED TOLERANCE, UNLESS OTHERWISE SPECIFIED:		CLEAVER-BROOKS The power of commitment HIGH LEVEL ASSEMBLY 50-60HP 15# ST. CFH BOILER N.T.S.
	FRACTIONAL: ±	DECIMAL: ±	
	HOLE LOCATIONS: ±	ANGLES: ±	
	DRILLED, PUNCHES OR SLOTTED HOLES: ±		
C	SHEET 1 OF 1		DATE: 11/20/2007 DRAWING NO.: 146 00554

7. High Level Assembly 50-60 HP 150#St.

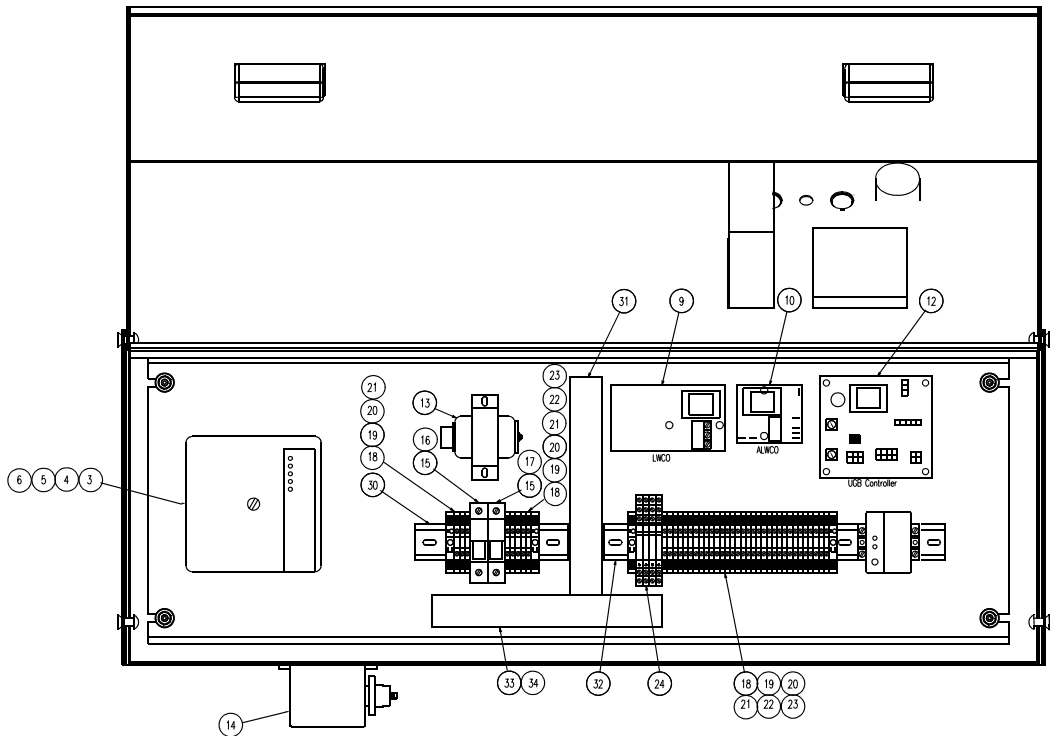
ITEM	QTY	50-60 HP 150# P/N	DESCRIPTION	
1	1	270C03313	Pressure Vessel Assembly	
2	1	146C00541	Burner Assembly	
3	1	507C08103	Control Piping	
4	1	940-5453	Safety Valve	
5	1	465C02581	Insulation And Lagging Assembly	
6	1	283C03333	Control Panel	
7	2	118B03637	Label, CFH Boiler Casing	
8	1	118B03638	Label, CFH Boiler Panel	
9	1	118A03634	Data Plate, CFH Boilers	
10	1	507C08107	Mounted Feedwater Piping	Optional
11	1	507C08105	Bottom Blowdown Piping	Optional
12	1	507C08115	Surface Blowoff Piping	Optional
13	1	157C02295	Surface Blowoff Dip Tube	Optional
14	12	868-00450	Capscrew, Hex. Hd. 3/8"-16 UNC x 4" Lg.	
15	1	914-00093	Retainer Ring, TruArc, .5" Shaft	
16	12	952-00392	Washer, Fender, 3/8" Bolt	
17	2	952-00111	Washer. Plated	
18	1	056C00297	Pin, Hinge, Front Door	
19	6	860-00596	Setscrew, Flat Pnt, 3/8"-16 UNC x .5" Lg.	
20	1	008B03606	Bracket, Gas Train Piping	
21	1	008B03643	Bracket, Blowdown Piping	
22	2	841-01122	U-Bolt With Nuts	
23	1	858-00091	Plug, .5" NPT	
24	1	118A03666	Name Plate, Drain Plug	



8. Control Panel (sheet 1 of 2)



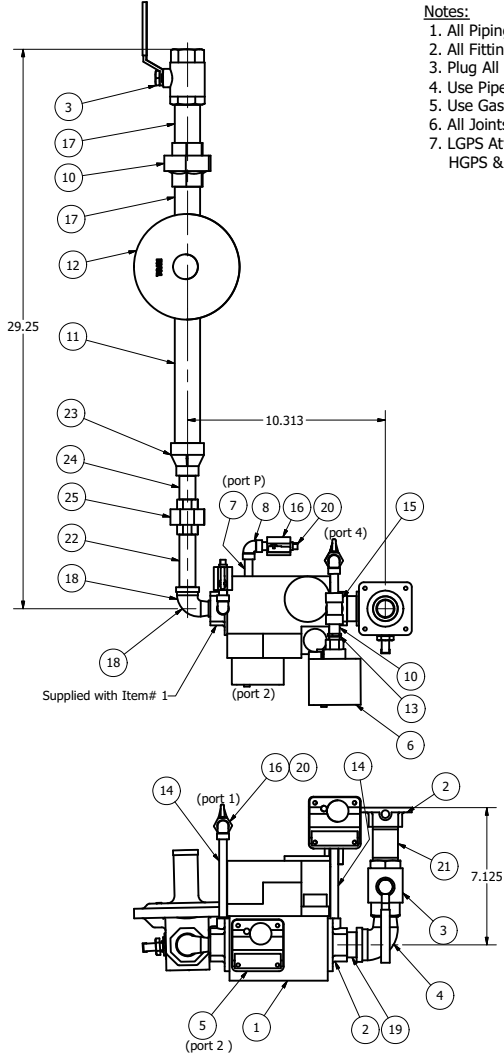
Control Panel (sheet 2 of 2)



	Item	Qty	10-25 HP	30-40 HP	Description
	1	1	119C00424	119C00424	Rear Cabinet, Electrical w/Sub Base
	2	1	817-03207	817-03207	Modulating Controller Model RWF40
	3	1	833-03162	833-03162	Flame Safeguard Chassis
	4	1	833-03163	833-03163	Flame Safeguard Programmer Module
	5	1	833-03160	833-03160	Flame Safeguard Flame Amplifier Module
	6	1	833-03165	833-03165	Flame Safeguard Wiring Base
Optional	7	1	833-02714	833-02714	Flame Safeguard Remote Display Module
Optional	8	1	833-02715	833-02715	Flame Safeguard Remote Display Module Mtg Kit
	9	1	833-03130	833-03130	Level Control, Dual Function, LWCO and Pump
	10	1	833-03131	833-03131	Controller, ALWCO, w/Reset Button
	11	1	008A00801	008A00801	Bracket, Mounting, Selector Switch
	12	1	833-03132	833-03132	Control, Universal Gas Blower
	13	1	832-00235	832-00235	Transformer, 120 VAC to 24 VAC
	14	1	832-02062	832-02062	Transformer, Ignition, Solid State
See Note	15	2	848-01166	848-01166	Fuse Block, Single Pole
	16	1	832-01881	832-01887	Fuse
	17	1	832-01908	832-01908	Fuse, 5.6 Amp
	18	42	832-02326	832-02326	Terminal Block
	19	4	832-02248	832-02248	Terminal End Retaining Anchor
	20	84	832-02327	832-02327	Terminal Lable Clip
	21	4	832-02328	832-02328	Terminal, Grounding
	22	2	832-02249	832-02249	Jumper, 2-Pole
	23	2	832-02250	832-02250	Jumper, 3-Pole
	24	4	833-02850	833-02850	Control Relay, Din Rail Mounted, SPDT
	25	2	836-01147	836-01147	Switch, Selector, 2 Position
	26	3	836-01136	836-01136	Contact Block, SPDT
	27	1	879-00995	879-00995	Name Plate, Burner OFF-ON
	28	1	879-00995	879-00995	Name Plate, Local/Remote
	29	1	836-01142	836-01142	Push Button Momentary Switch
	30	1	879-00995	879-00995	Name Plate, Alarm Silence
	31	1	817-03571	817-03571	Alarm Horn
	32	1	832-01951	832-01951	Din Rail
	33	1	848-00797	848-00797	Wire Duct, 1.5" x 2.0" x 24"
	34	1	019-01345	019-01345	Cover, Wire Duct
	35	7	881-00348	881-00348	Latch, Plastic
	36	1	119C00423	119C00423	Front Cabinet, Electrical w/Cutouts

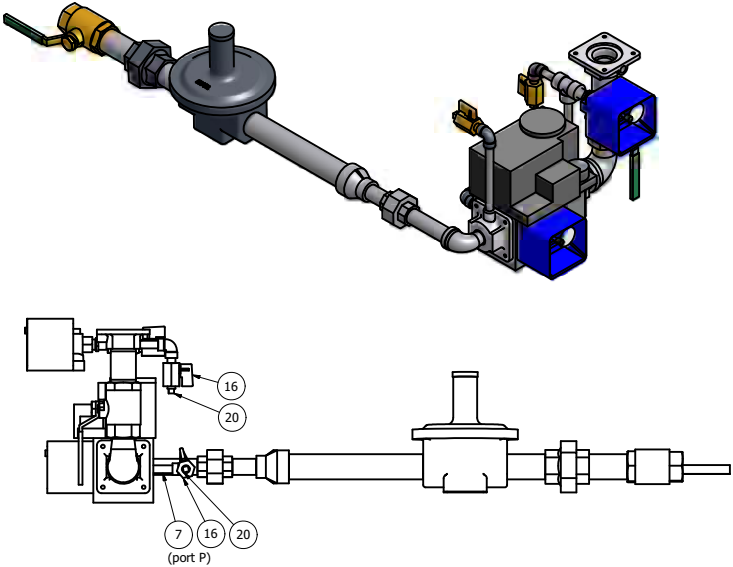
Note: If Blower Motor is 230 VAC, replace (1) Item #15 with (1) Double Pole Fuse Block P/N 848-01479, and add (2) 6 Amp Fuses for Item #16.

9. Gas Train 10 HP

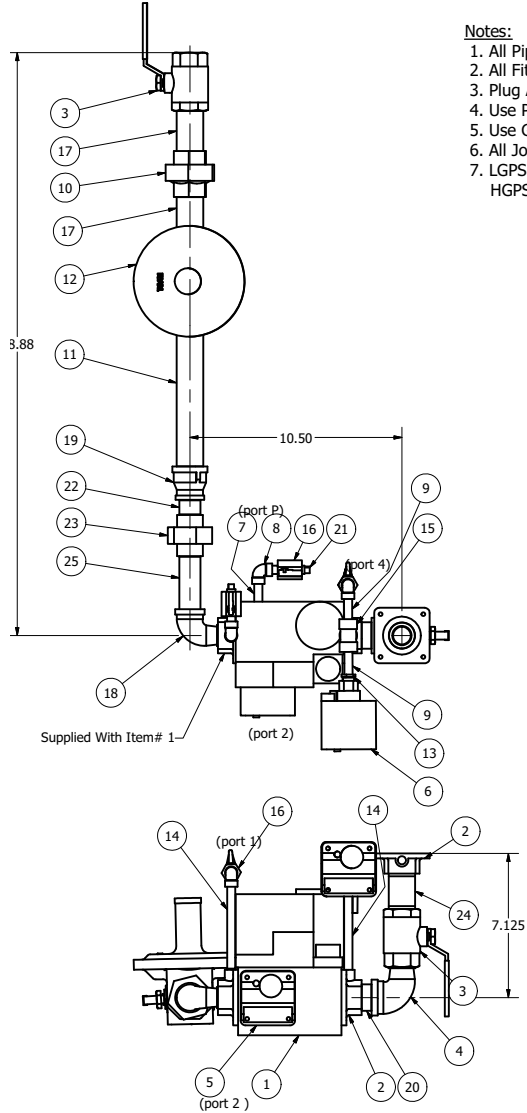


- Notes:
- 1. All Piping To Be SA106 Gr.B Sch.80
 - 2. All Fittings To Be 150# M.I. Unless Otherwise Specified.
 - 3. Plug All Unused Openings.
 - 4. Use Pipe Joint Compound On All Threaded Joints.
 - 5. Use Gaskets/O-Rings Where Applicable.
 - 6. All Joints Must Be Gas Tight.
 - 7. LGPS Attached To Port 2, First Leak Test In Port P, HGPS & Second Leak Test Attached To Port 4.

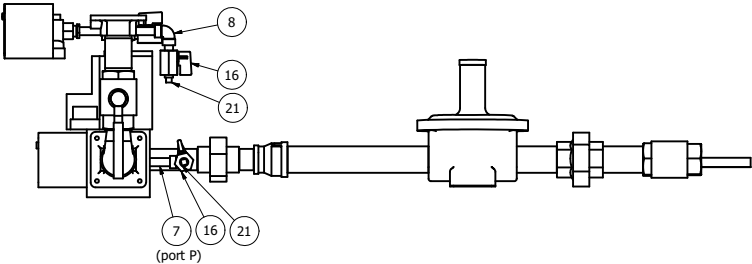
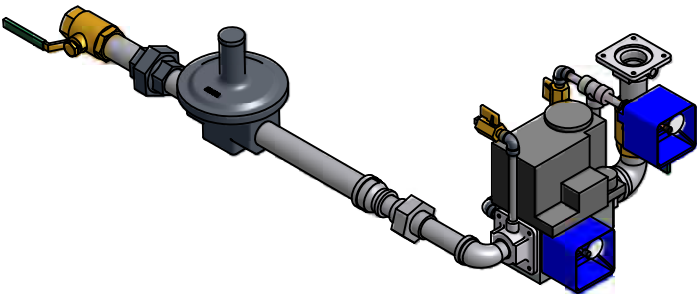
ITEM	QTY	PART NO.	DESCRIPTION
1	1	940-07162	Valve, Gas, Combo, 120V, .5" NPT. C/W .5" Adapter.
2	2	800-00092	Adapter, 1" NPT Pipe
3	2	941-02632	Valve, Ball, 1" NPT
4	1	859-00108	Elbow, Street, 90, 1" NPT. 150#M.I.
5	1	817-02414	Low Gas Pressure Switch
6	1	817-02420	High Gas Pressure Switch
7	1	857-00719	Nipple, .125" NPT. Sch.80 x Closed
8	3	859-00077	Elbow, 90, .125" NPT, 150#M.I.
9	1	857-01626	Nipple, .125" NPT. Sch.80 x 1.5" Lg.
10	1	858-00166	Union, 1" NPT. 150# M.I.
11	1	857-00642	Nipple, 1" NPT. Sch.80 x 8.0" Lg.
12	1	918-00032	Gas Pressure Regulator, Maxitrol #RV61, 1" NPT.
13	1	847-01172	Bushing, Hex, .25" x .125" NPT
14	2	857-02199	Nipple, .125" NPT. Sch.80 x 4.5" Lg.
15	1	859-00021	Tee, 150# M.I. .125" NPT.
16	3	825-00239	Leakage Test Cock, .125" NPT
17	2	857-00639	Nipple, 1" NPT. Sch.80 x 3.0" Lg.
18	1	859-00107	Elbow, Street, 90, .75" NPT. 150# M.I.
19	1	857-00673	Nipple, 1" NPT. Sch.80 x 1.5" Lg.
20	3	858-00088	Plug, Pipe, Square head, .125" NPT
21	1	857-00751	Nipple, 1" NPT. Sch.80 x 2.5" Lg.
22	1	857-00742	Nipple, .5" NPT. Sch.80 x 3.5" Lg.
23	1	847-00532	Reducer Coupling, 150# M.I. 1" x .5"
24	1	857-00659	Nipple, .5" NPT. Sch.80 x 2" Lg.
25	1	858 00164	Union, 1/2" NPT 150# M.I.



10. Gas Train 15 HP

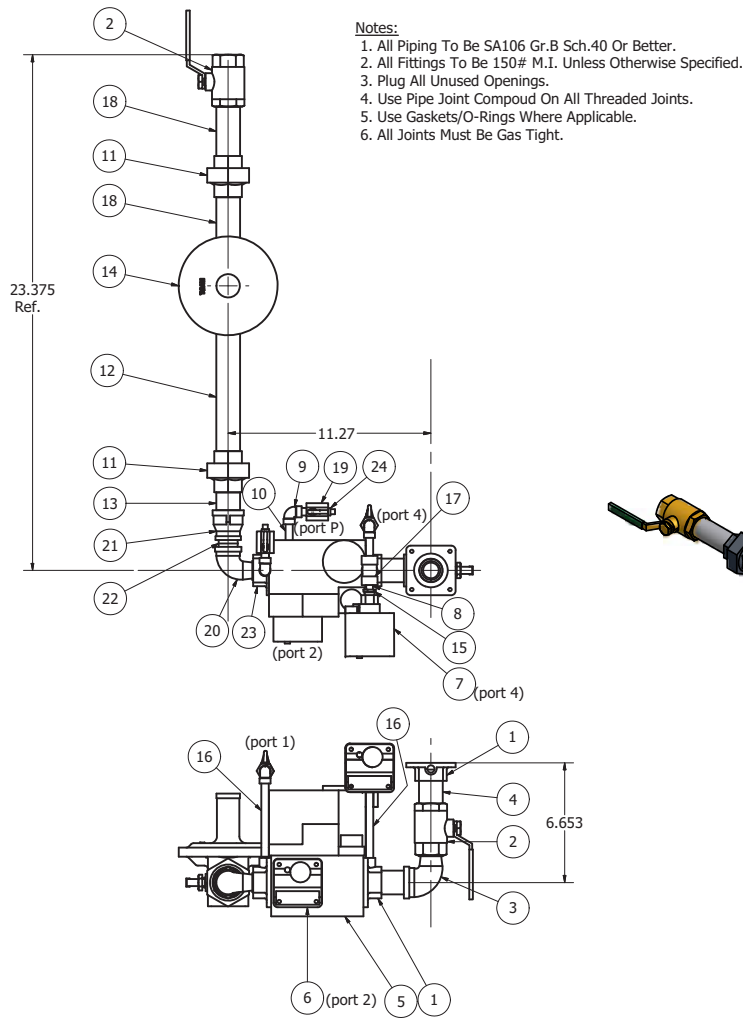


- Notes:**
- 1. All Piping To Be SA106 Gr.B Sch.80
 - 2. All Fittings To Be 150# M.I. Unless Otherwise Specified.
 - 3. Plug All Unused Openings.
 - 4. Use Pipe Joint Compound On All Threaded Joints.
 - 5. Use Gaskets/O-Rings Where Applicable.
 - 6. All Joints Must Be Gas Tight.
 - 7. LGPS Attached To Port 2, First Leak Test In Port P, HGPS & Second Leak Test Attached To Port 4.

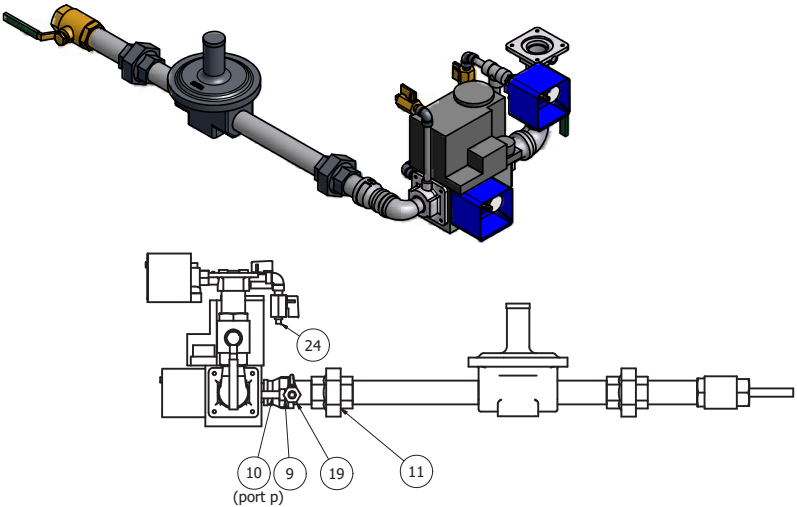


ITEM	QTY	PART NO.	DESCRIPTION
1	1	940-07163	Valve, Gas, Combo, 120V, .75" NPT. C/W .75" Adapter.
2	2	800-00092	Adapter, 1" NPT Pipe
3	2	941-02632	Valve, Ball, 1" NPT
4	1	859-00108	Elbow, Street, 90, 1" NPT. 150#M.I.
5	1	817-02414	Low Gas Pressure Switch
6	1	817-02420	High Gas Pressure Switch
7	1	857-00719	Nipple, .125" NPT. Sch.80 x Closed
8	3	859-00077	Elbow, 90, .125" NPT, 150#M.I.
9	2	857-01626	Nipple, .125" NPT. Sch.80 x 1.5" Lg.
10	1	858-00166	Union, 1" NPT. 150# M.I.
11	1	857-00642	Nipple, 1" NPT. Sch.80 x 8.0" Lg.
12	1	918-00032	Gas Pressure Regulator, Maxitrol #RV61, 1" NPT.
13	1	847-01172	Bushing, Hex, .25" x .125" NPT
14	2	857-02199	Nipple, .125" NPT. Sch.80 x 4.5" Lg.
15	1	859-00021	Tee, 150# M.I. .125" NPT.
16	3	825-00239	Leakage Test Cock, .125" NPT
17	2	857-00639	Nipple, 1" NPT. Sch.80 x 3.0" Lg.
18	1	859-00107	Elbow, Street, 90, .75" NPT. 150# M.I.
19	1	847-00533	Reducer Coupling, 150# M.I. 1" x .75"
20	1	857-00673	Nipple, 1" NPT, Sch.80 x 1.5" Lg.
21	3	858-00088	Plug, Pipe, Square head, .125" NPT
22	1	857-00745	Nipple, .75" NPT. Sch.80 x 1.5" Lg.
23	1	858-00165	Union, .75" NPT. 150# M.I.
24	1	857-00751	Nipple, 1" NPT, Sch.80 x 2.5" Lg.
25	1	857-00747	Nipple, .75" NPT. Sch.80 x 3.5" Lg.

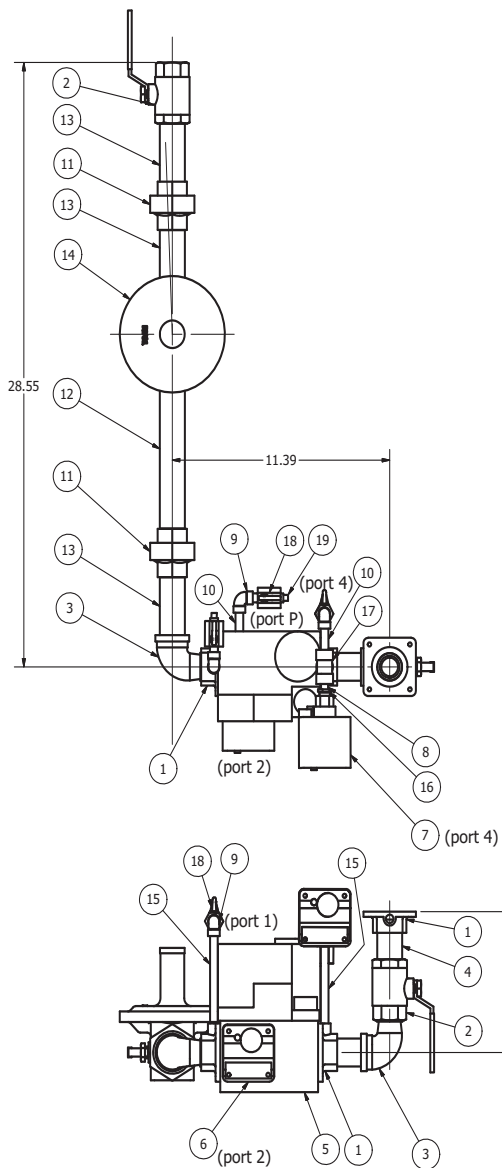
11. Gas Train 20 HP



ITEM	QTY	PART NO.	DESCRIPTION
1	2	800-00092	Adapter, 1"
2	2	941-02632	Valve, Ball
3	1	859-00108	Elbow, Street, 90
4	2	857-00751	Nipple
5	1	940-07163	Valve, Gas, 120V, .75"
6	1	817-02414	Low Gas Pressure Switch
7	1	817-02420	High Gas Pressure Switch
8	1	857-00719	Nipple
9	3	859-00077	Elbow, 90
10	2	857-01626	Nipple
11	2	858-00166	Union
12	1	857-01360	Nipple
13	1	857-00840	Nipple
14	1	918-00032	Gas Pressure Regulator
15	1	847-01172	Bushing, Hex.
16	2	857-02199	Nipple
17	1	859-00021	Tee
18	2	857-00842	Nipple
19	3	825-00239	Leakage Test Cock
20	1	859-00107	Elbow, Street, 90
21	1	847-00533	Reducer Coupling
22	1	857-00708	Nipple, Close
23	1	800-00090	Adapter, .75"
24	3	858-00088	Plug

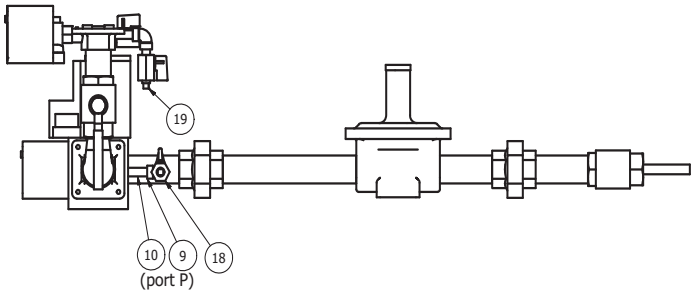
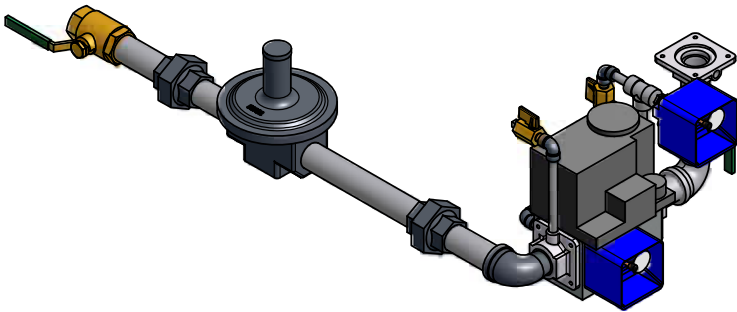


12. Gas Train 25 HP

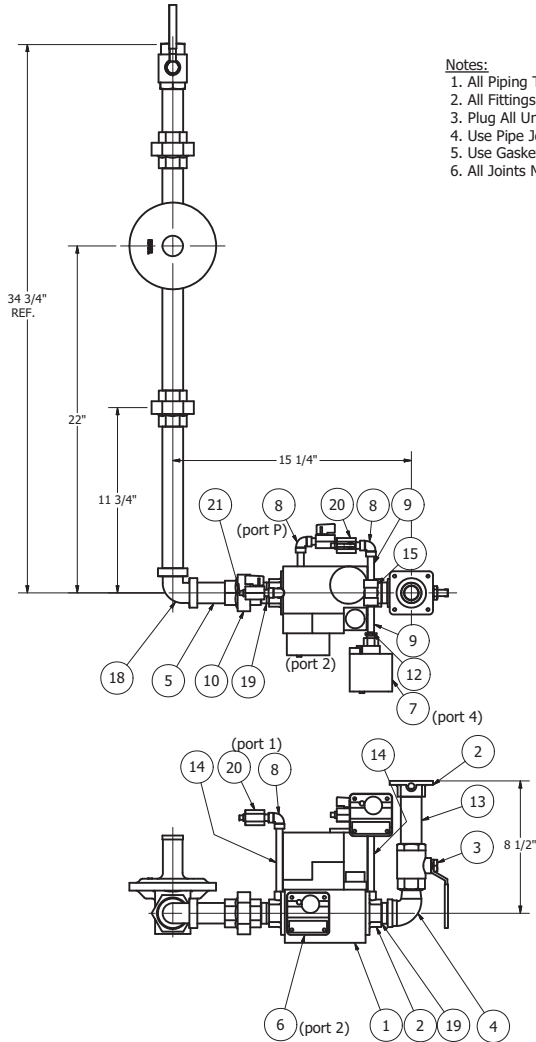


- Notes:
- 1. All Piping To Be SA106 Gr.B Sch.40 Or Better.
 - 2. All Fittings To Be 150# M.I. Unless Otherwise Specified.
 - 3. Plug All Unused Openings.
 - 4. Use Pipe Joint Compound On All Threaded Joints.
 - 5. Use Gaskets/O-Rings Where Applicable.
 - 6. All Joints Must Be Gas Tight.

ITEM	QTY	PART NUMBER	DESCRIPTION
1	3	800-00092	Adapter, 1"
2	2	941-02632	Valve,ButterBall
3	2	859-00108	Elbow, Street
4	2	857-01049	Nipple
5	1	940-07164	Valve, Gas, 120V, 1"
6	1	817-02414	Low Gas Pressure Switch
7	1	817-02420	High Gas Pressure Switch
8	1	857-01511	Nipple,Close
9	3	859-00077	Elbow, 90
10	2	857-01113	Nipple
11	2	858-00166	Union
12	1	857-01350	Nipple
13	3	857-00842	Nipple
14	1	918-00032	Gas Pressure Regulator, Maxitrol # RV61, 1"
15	2	857-02199	Nipple
16	1	847-01172	Bushing, Hex
17	1	859-00021	Tee
18	3	825-00239	Leakage Test Cock
19	3	858-00088	Plug

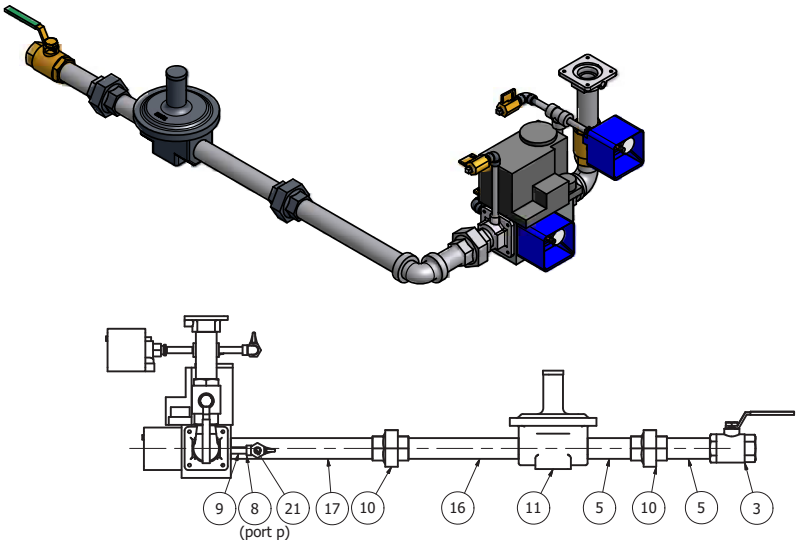


13. Gas Train 30 HP

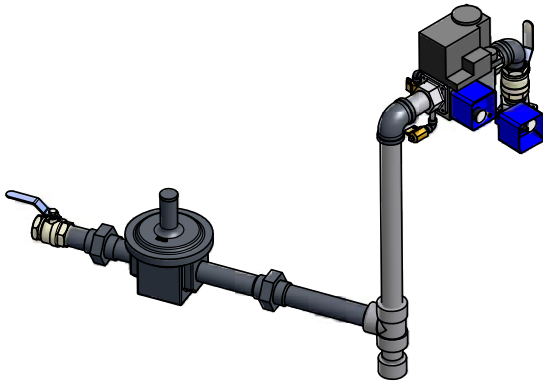
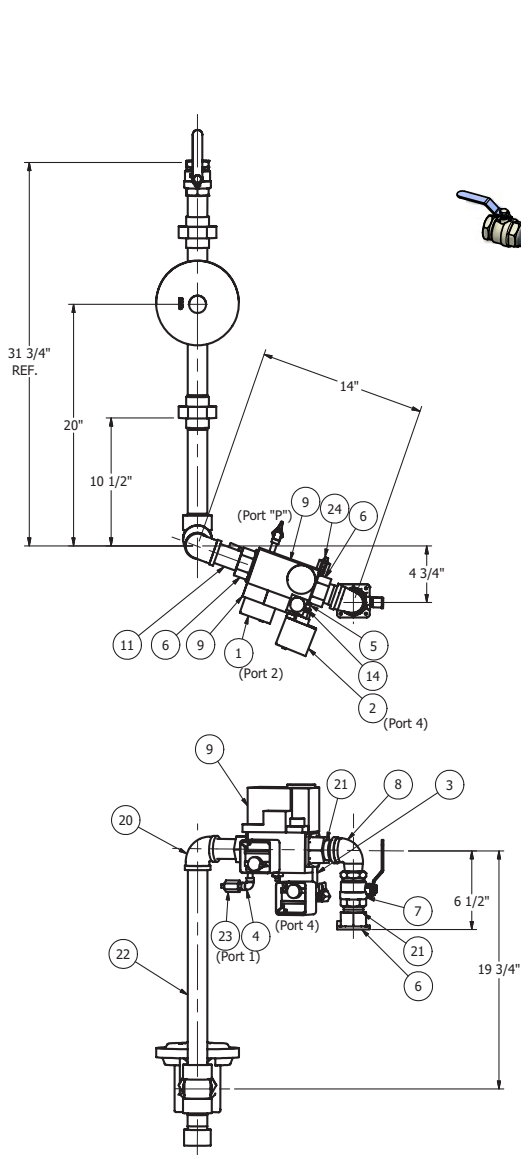


- Notes:
- 1. All Piping To Be SA106 Gr.B Sch.40 Or Better.
 - 2. All Fittings To Be 150# M.I. Unless Otherwise Specified.
 - 3. Plug All Unused Openings.
 - 4. Use Pipe Joint Compound On All Threaded Joints.
 - 5. Use Gaskets/O-Rings Where Applicable.
 - 6. All Joints Must Be Gas Tight.

ITEM	QTY	PART NO.	DESCRIPTION
1	1	940-07164	Valve, Gas, 120V, 1"
2	3	800-00092	Adapter, 1"
3	2	941-02632	Valve, Ball
4	1	859-00108	Elbow, Street
5	4	857-00639	Nipple
6	1	817-02414	Low Gas Pressure Switch
7	1	817-02420	High Gas Pressure Switch
8	3	859-00077	Elbow, 90
9	3	857-01113	Nipple
10	3	858-00166	Union
11	1	918-00032	Gas Pressure Regulator, Maxitrol #RV61, 1"
12	1	847-01172	Bushing, Hex
13	2	857-00644	Nipple
14	2	857-02199	Nipple
15	1	859-00021	Tee
16	1	857-01350	Nipple
17	1	857-00705	Nipple
18	1	859-00082	Elbow, 90
19	2	857-00638	Nipple
20	3	825-00239	Leakage Test Cock
21	3	858-00088	Plug

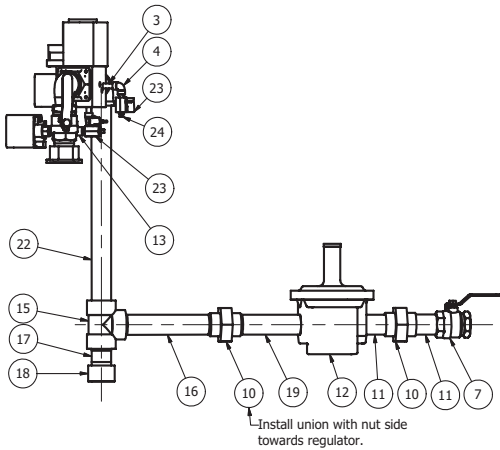


14. Gas Train 40 HP



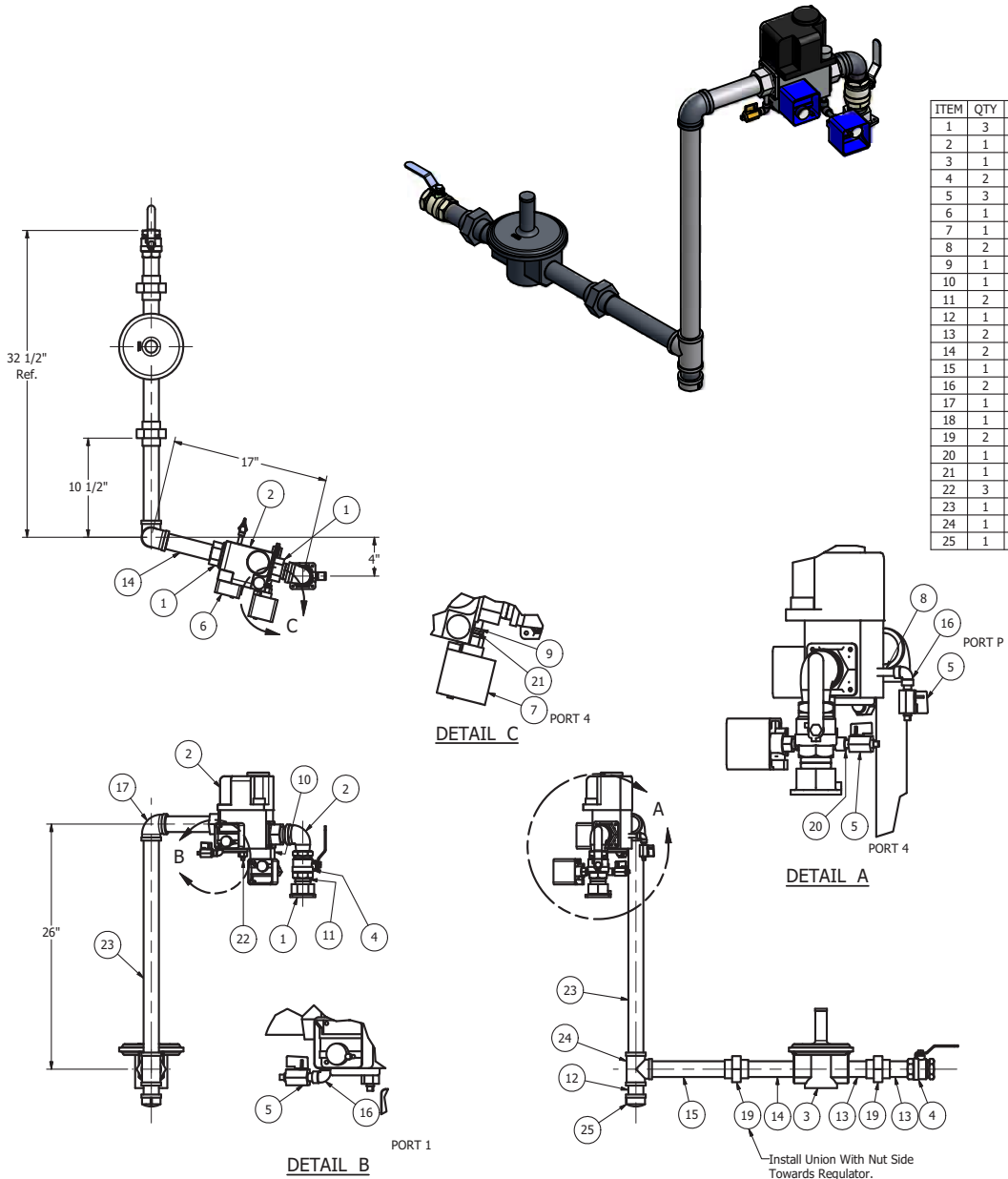
ITEM	QTY	PART NO.	DESCRIPTION
1	1	817-02414	Low Gas Pressure Switch
2	1	817-02420	High Gas Pressure Switch
3	3	857-02202	Nipple
4	2	859-00077	Elbow, 90
5	2	857-01107	Nipple
6	3	800-00093	Adapter, 1.25"
7	2	941-02633	Valve, ButterBall
8	1	859-00109	Elbow, Street, 90
9	1	940-07165	Valve, Gas, 120V, 1.25"
10	2	858-00167	Union
11	3	857-01135	Nipple
12	1	918-00850	Gas Pressure Regulator, 1.25" RV81
13	1	859-00021	Tee
14	1	847-01172	Bushing, Hex.
15	1	859-00026	Tee
16	1	900-00360	Bulk Pipe
17	1	857-00836	Nipple
18	1	858-00131	Cap, Pipe
19	1	857-01457	Nipple
20	1	859-00083	Elbow, 90
21	2	857-01242	Nipple
22	1	900-00360	Bulk Pipe
23	3	825-00239	Leakage Test Cock
24	3	858-00088	Plug

- Notes:
1. All Piping To Be SA106 Gr.B Sch.40 Or Better.
 2. All Fittings To Be 150# M.I. Unless Otherwise Specified.
 3. Plug All Unused Openings.
 4. Use Pipe Joint Compound On All Threaded Joints.
 5. Use Gaskets/O-Rings Where Applicable.
 6. All Joints Must Be Gas Tight.



15. Gas Train 50-60 HP

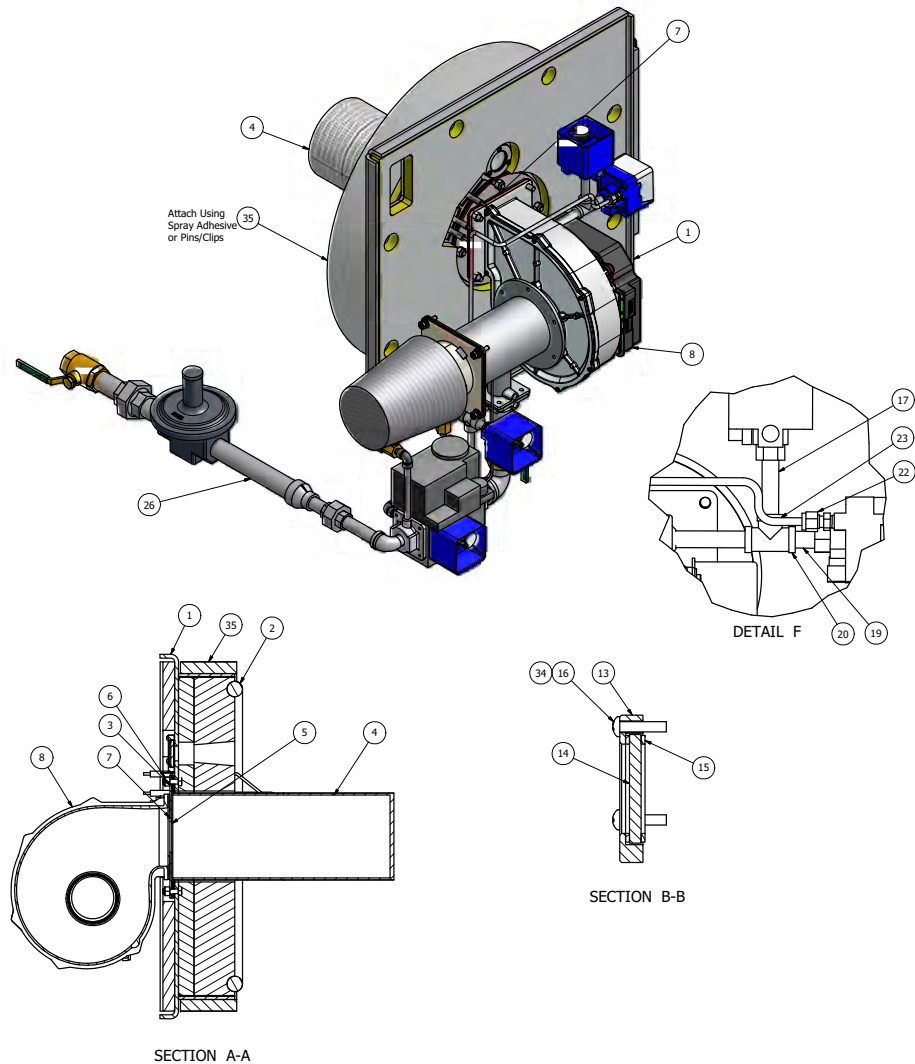
Part No. 750-222



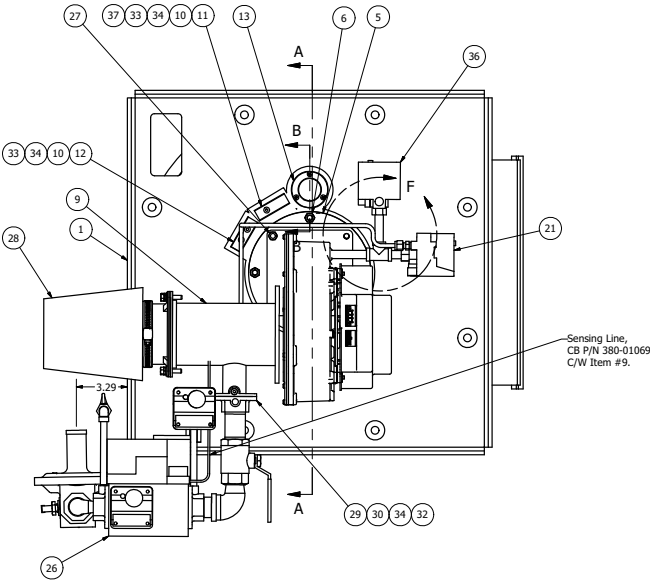
ITEM	QTY	PART NO.	DESCRIPTION
1	3	800-00093	Adapter, 1.25" NPT Pipe
2	1	940-07235	Valve, Gas, 120VAC 1-1/4"
3	1	918-00850	Gas Pressure Regulator
4	2	941-01945	Ball Valve
5	3	825-00239	Leakage Test Cock
6	1	817-02414	Low Gas Pressure Switch
7	1	817-02420	High Gas Pressure Switch
8	2	857-01511	Nipple, .125"
9	1	857-01107	Nipple, .125"
10	1	857-02202	Nipple, .125"
11	2	857-01242	Nipple, 1.25"
12	1	857-00836	Nipple, 1.25"
13	2	857-01135	Nipple, 1.25"
14	2	857-01457	Nipple, 1.25"
15	1	857-00835	Nipple, 1.25"
16	2	859-00077	Elbow, 90, .125"
17	1	859-00083	Elbow, 90, 1.25"
18	1	859-00109	Elbow, Street, 90, 1.25"
19	2	858-00167	Union, 1.25"
20	1	859-00021	Tee, .125"
21	1	847-01172	Bushing
22	3	858-00088	Plug
23	1	900-00360	Bulk Pipe
24	1	859-00026	Tee
25	1	858-00131	Cap, Pipe

- Notes:
- 1. All Piping To Be SA106 Gr.B Sch.40 Or Better.
 - 2. All Fittings To Be 150# M.I. Unless Otherwise Specified.
 - 3. Plug All Unused Openings.
 - 4. Use Pipe Joint Compound On All Threaded Joints.
 - 5. Use Gaskets/O-Rings Where Applicable.
 - 6. All Joints Must Be Gas Tight.

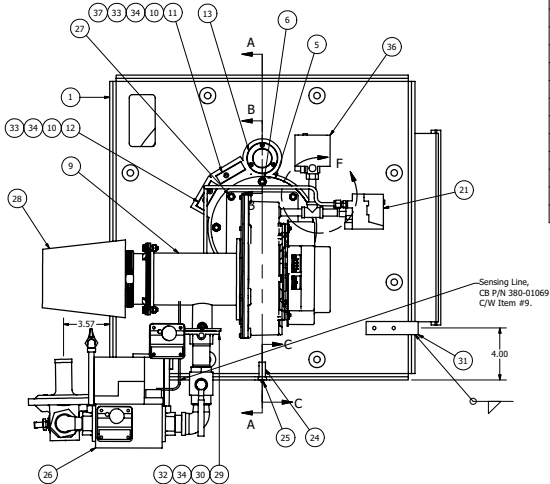
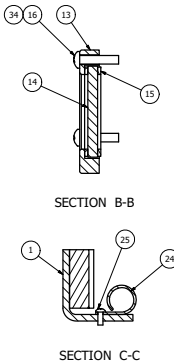
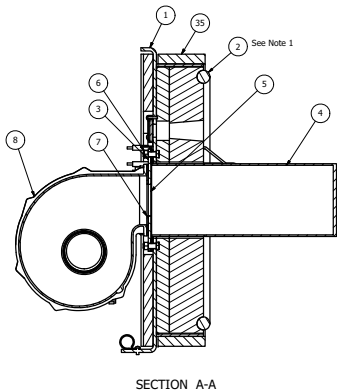
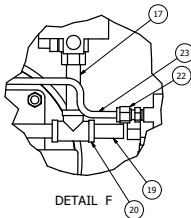
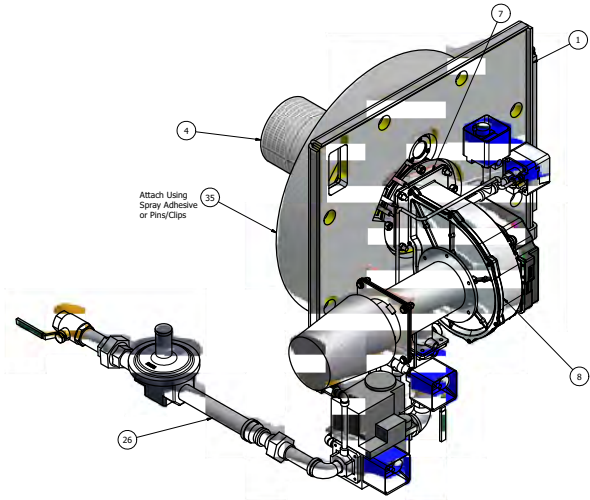
16 Burner Assembly 10 HP



Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	132C02497	Insulated Front Door Assembly
2	1	853-00982	Gasket, Rope, 1 1/4" Dia. x 78" LG.
3	1	380-01053	Gasket, Adapter Plate to Vessel
4	1	380-01055	Burner Can Unit
5	1	380-01094	Adapter Plate, Vessel To Blower
6	4	869-00030	Nut, Hex, 3/8"-16 UNC
7	1	380-01037	Gasket, Adapter Plate to Blower
8	1	894-04076	Blower Unit, 115V
9	1	048-00659	Venturi, Air Gas Premix, C/W Sensing Line
10	2	380-01032	Gasket Electrode (C/W Items #11 and #12)
11	1	380-01062	Electrode, Single
12	1	380-01061	Electrode, Double
13	1	065C00879	Retainer, Sight Port
14	1	851-00026	Sight Glass Pyrex, .1875" x 1.75" O.D
15	1	853-00213	Sight Glass Gasket, .0625" x 1.438" I.D x 1.719" O.D
16	1	860-00097	Machine Screw, # 8-32 UNC x .75 LG.
17	1	857-00728	Nipple, .25" NPT.SCH.80 x 2.5" LG.
18	-	-----	-----
19	1	857-00726	Nipple, .25" NPT.SCH.80 x 1.5" LG.
20	1	859-00022	ASME B16.3 Tee - Class 150 1/4
21	1	817-03468	Combustion Air Proving Switch
22	2	845-00468	Connector, .125" NPT. x .25" O.D
23	1	939-00661	Tubing, Aluminum, .25" O.D x .035" Wall x 25" LG.
24	-	-----	-----
25	-	-----	-----
26	1	507C08213	Piping, Gas Train
27	2	869-00198	Nut, Hex, 5/16"-18 UNC
28	1	880C01858	Air Filter Kit 4"
29	1	800-00098	Venturi Gasket
30	1	868-00536	Socket Head Capscrew, #10-24 UNC x 1" LG.
31	-	-----	-----
32	1	869-00061	Nut, Hex, Machine Screw, #10-24 UNC
33	1	993-16083	Capscrew Hex, #10-32 x 1/2" LG.
34	1	993-15760	External Lock Washer, #10
35	1	872-00381	Board Insulation
36	1	817-02420	Switch, High Air Pressure
37	1	848-00157	Terminal, Ignition, Spring Snap, 7mm Cable



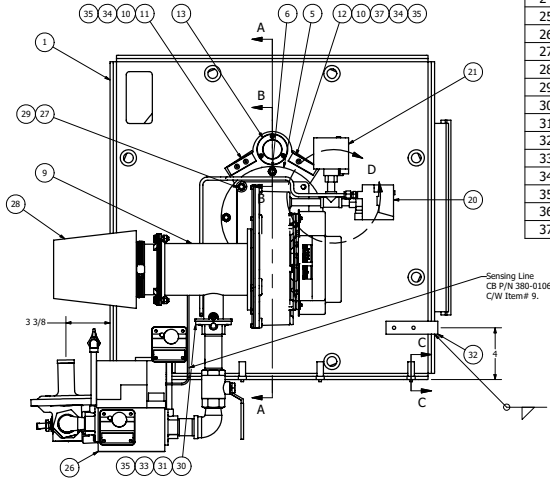
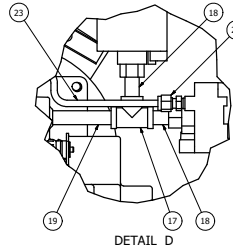
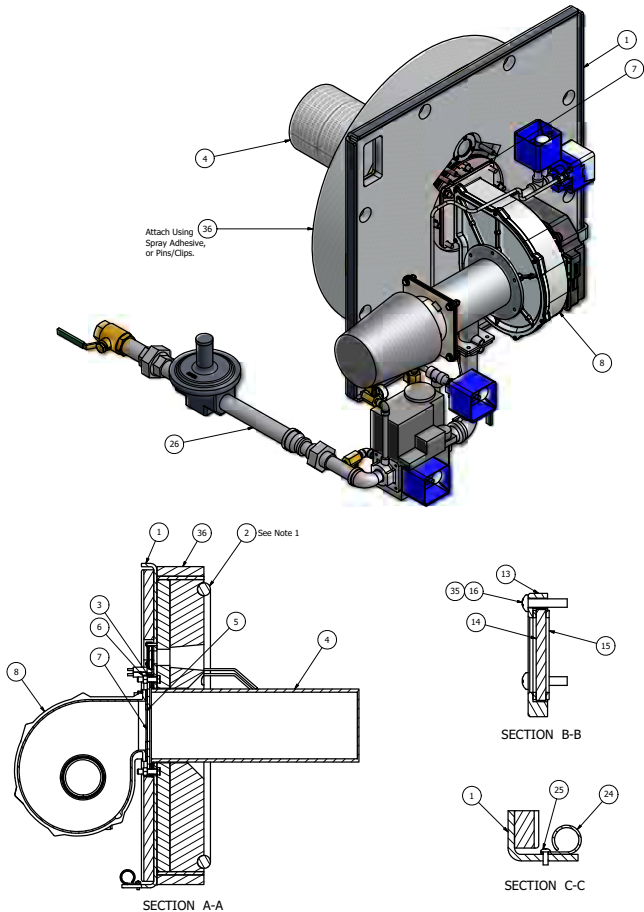
17. Burner Assembly 15 HP



FOR LISTING			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	132C02497	Insulated Front Door Assembly
2	1	853-00982	Gasket, Rope, 1-1/4" Dia. x 78" LG.
3	1	380-01053	Gasket, Adapter Plate to Vessel
4	1	380-01045	Burner Canister
5	1	380-01052	Adapter Plate, Vessel To Blower
6	4	869-00030	Nut, Hex, 3/8"-16 UNC
7	1	380-01037	Gasket, Adapter Plate to Blower
8	1	894-04076	Blower Unit, 115V
9	1	048-00659	Venturi, Air Gas Premix, C/W Sensing Line
10	2	380-01032	Gasket Electrode (C/W Items #11 and #12)
11	1	380-01062	Electrode, Single
12	1	380-01061	Electrode, Double
13	1	065C00879	Retainer, Sight Port
14	1	851-00026	Sight Glass Pyrex, .1875" x 1.75" O.D
15	1	853-00213	Sight Glass Gasket, .0625" x 1.438" I.D x 1.719" O.D
16	1	860-00097	Machine Screw, # 8-32 UNC x .75 LG.
17	2	857-00728	Nipple, .25" NPT.SCH.80 x 2.5" LG.
19	1	857-00726	Nipple, .25" NPT.SCH.80 x 1.5" LG.
20	1	859-00022	ASME B16.3 Tee - Class 150 1/4
21	1	817-03468	Combustion Air Proving Switch
22	2	845-00468	Connector, .125" NPT. x .25" O.D
23	1	939-00661	Tubing, Aluminum, .25" O.D x .035" Wall x 25" LG.
24	1	928-00228	Cable Ring Loop, McMaster Carr#7572K17 Self Closing
25	1	860-00033	Machine Screw, #10-32 UNF x .375" LG.
26	1	507-07950	Piping, Gas Train
27	4	869-00198	Nut, Hex, 5/16"-18 UNC
28	1	880C01858	Air Filter Kit 4"
29	1	800-00098	Venturi Gasket
30	1	868-00536	Socket Head Capscrew, #10-24 UNC x 1" LG.
31	1	008C03620	Bracket,Junction Box
32	1	869-00061	Nut, Hex, Machine Screw, #10-24 UNC
33	1	993-16083	Capscrew Hex, #10-32 x 1/2" LG.
34	1	993-15760	External Lock Washer, #10
35	1	872-00381	Board Insulation
36	1	817-02420	Switch, High Air Pressure
37	1	848-00157	Terminal, Ignition, Spring Snap, 7mm Cable

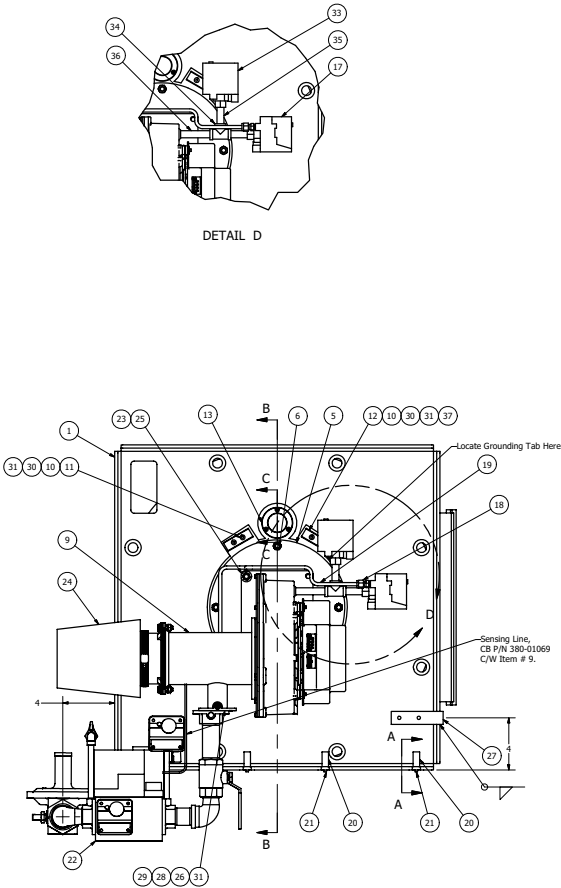
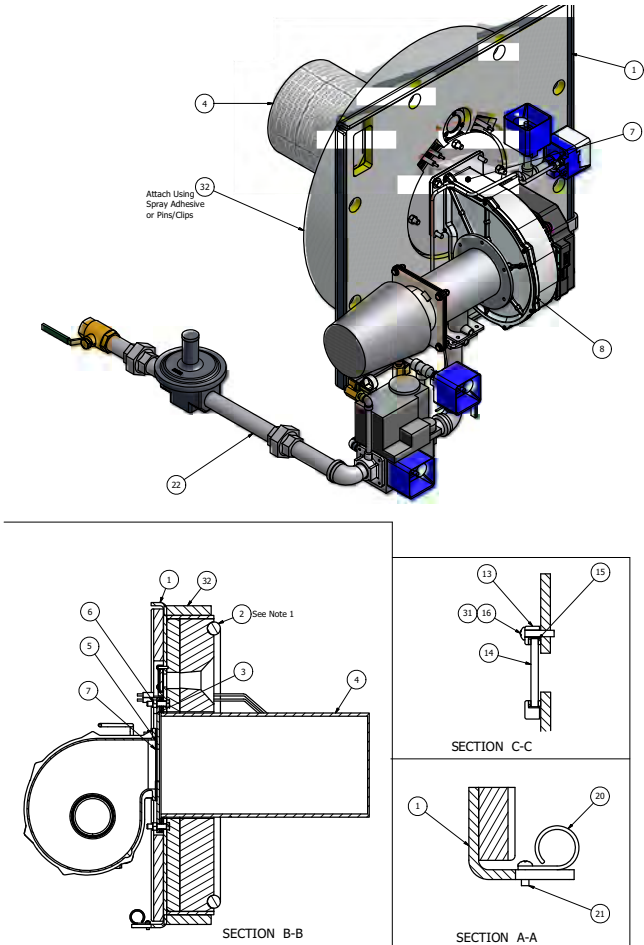
18. Burner Assembly 20 HP

Part No. 750-222



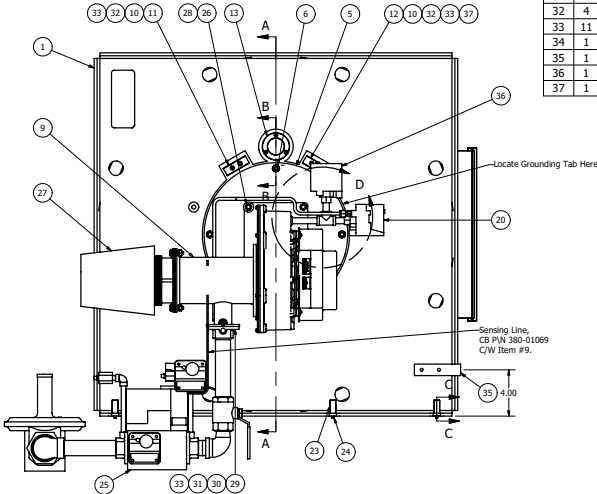
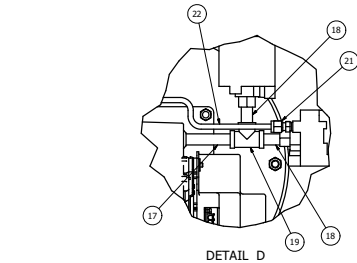
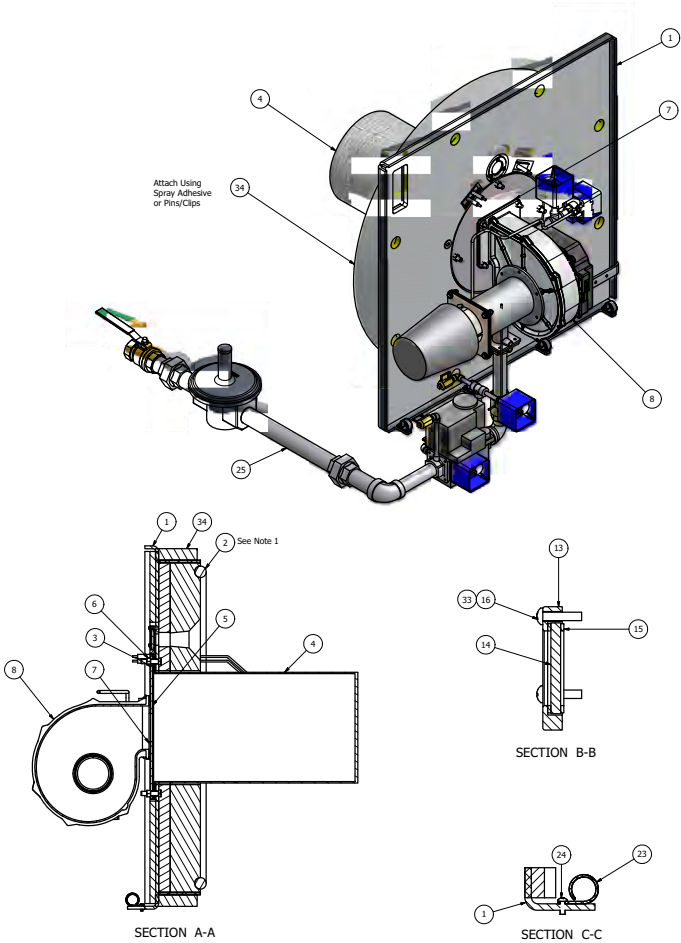
Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	132C02544	Insulated Front Door Assembly
2	1	853-00982	Gasket Rope, 1-1/4" DIA x 85" LG.
3	2	380A01053	Gasket Adapter Plate to Door
4	1	380-01045	Burner Canister
5	1	380A01052	Adapter Plate, Blower to Door
6	4	869-00030	Nut, Hex. 3/8"-16 UNC
7	1	380A01037	Gasket, Adapter Plate to Blower
8	1	894-04076	Blower Unit, 115V
9	1	048-00655	Venturi, Air Gas Premix, C/W Sensing Line
10	-	380A01032	Gasket, Electrode (Included With Items #11 and #12)
11	1	380-01061	Electrode, Double (C/W Gasket)
12	1	380-01060	Electrode, Single (C/W Gasket)
13	1	065C00879	Retainer, Sight Port
14	1	851-00026	Sight Glass, Pyrex, .1875" x 1.75" OD.
15	2	853-00213	Sight Glass Gasket, .0625" x 1.438" ID. x 1.719" OD.
16	3	860-00097	Machine Screw, #8-32 UNC x .75"
17	1	859-00022	ASME B16.3 Tee - Class 150 1/4"
18	2	857-00726	Nipple, .25" NPT.SCH.80 x 1.5" LG.
19	1	857-00679	Nipple, .25" NPT.SCH.80 x 3" LG.
20	1	817-03468	Combustion Air Proving Switch
21	1	817-02420	Switch, High Air Pressure
22	2	845-00468	Connector, .125" NPT. x .25" OD.
23	1	939-00661	Tubing, Aluminum, .25" OD. x .035" Wall x 25" LG
24	4	928-00228	Cable Ring Loop, McMaster Carr# 7572K17 Self-Closing
25	4	860-00033	Machine Screw, #10-32 UNF x .375" LG.
26	1	507C07932	Piping, Gas Train
27	4	869-00036	Nut, Hex. 5/16-18 UNC
28	1	880C01858	Air Filter Kit, 4"
29	4	952-00145	Washer, 1/4" Flat
30	1	800-00098	Venturi Gasket
31	4	868-00536	Socket Head Cap Screws, #10-24 UNC x 1" LG.
32	1	008C03620	Bracket,Junction Box
33	4	869-00061	Nut, Hex, Machine Screw, #10-24 UNC
34	4	993-16083	Capscrew, Hex. #10-32 x 1/2" LG.
35	11	993-15760	External Lock Washer, #10
36	1	872-00381	Board Insulation, 1" TH. x 3 5/8" x 72 1/4" LG.
37	1	848-00157	Terminal, Ignition, Straight, Spring Snap, 7mm Cable

19. Burner Assembly 25 HP



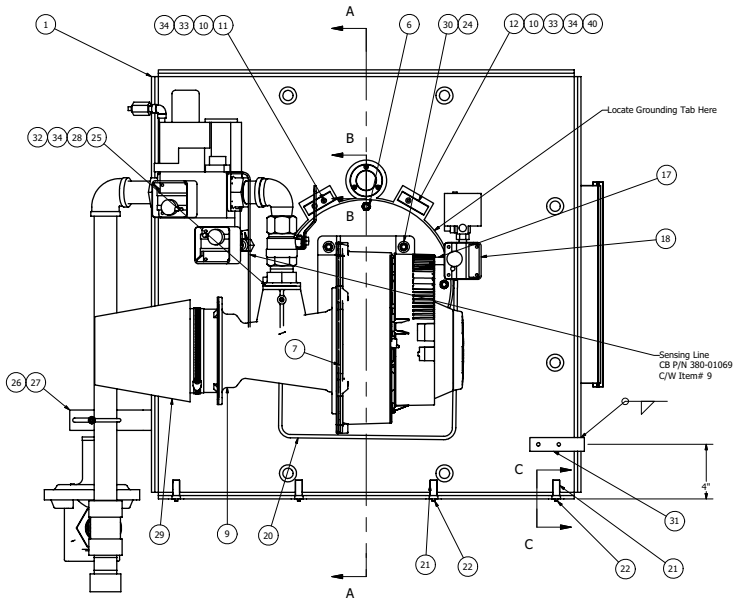
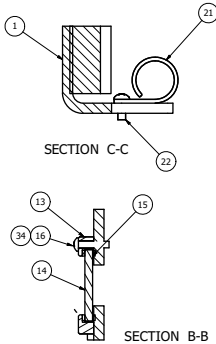
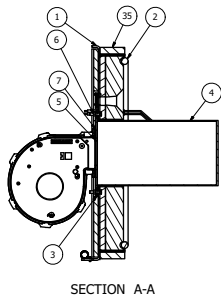
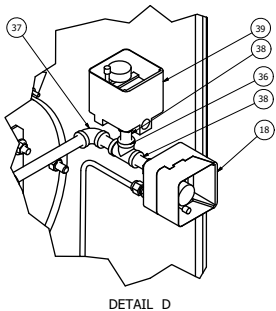
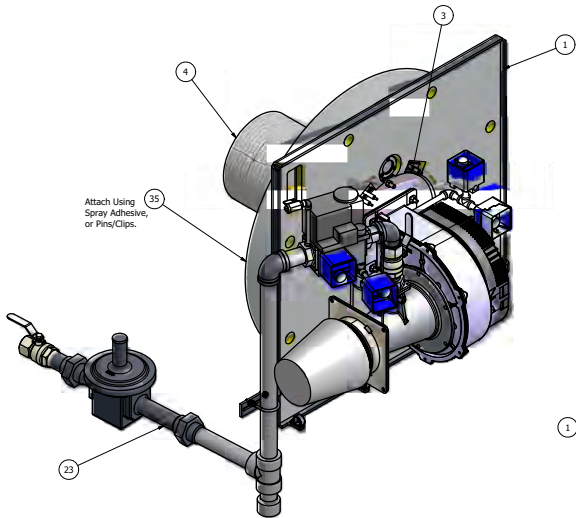
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	132C02490	INSULATED FRONT DOOR ASSEMBLY
2	1	853-00982	GASKET ROPE, 1-1/4" DIA X 85" LG.
3	2	380A01033	GASKET ADAPTER PLATE TO DOOR
4	1	380-01029	BURNER CANISTER
5	1	380A01035	ADAPTER PLATE, BLOWER TO DOOR
6	4	869-00030	NUT, HEX. 3/8"-16 UNC
7	1	380A01037	GASKET, ADAPTER PLATE TO BLOWER
8	1	894-04076	BLOWER UNIT, 115V
9	1	048-00655	VENTURI, AIR GAS PREMIX, C/W SENSING LINES
10	2	380A01032	GASKET, ELECTRODE (C/W ITEMS #11 AND #12)
11	1	380A01061	ELECTRODE, DOUBLE
12	1	380A01060	ELECTRODE, SINGLE
13	1	065C00879	RETAINER, SIGHT PORT
14	1	851-00026	SIGHT GLASS, PYREX, .1875"X 1.75" OD
15	2	853-00213	SIGHT GLASS GASKET, .0625" X 1.438" ID X 1.719" C
16	3	860-00097	MACHINE SCREW, #8-32 UNC X .75" LG.
17	1	817-03468	COMBUSTION AIR PROVING SWITCH
18	2	845-00468	CONNECTOR, .125" NPT. X 25" OD
19	1	939-00661	TUBING, ALUMINUM, .25" OD X .035" WALL X 25" LG
20	4	928-00228	CABLE RING LOOP,
21	4	860-00033	MACHINE SCREW, #10-32 UNF X .375" LG.
22	1	507C08099	PIPING, GAS TRAIN
23	1	869-00036	NUT, HEX. 5/16"-18 UNC
24	1	880C01858	AIR FILTER KIT, 4"
25	4	952 00145	WASHER, 1/4" FLAT
26	1	800-00098	VENTURI GASKET
27	1	008C03620	BRACKET, JUNCTION BOX
28	4	868-00536	SOCKET HEAD CAP SCREW, #10-24 UNC X 1" LG.
29	4	869-00061	NUT, HEX, MACHINE SCREW, #10-24 UNC
30	4	993-16083	CAPSCREW, HEX. #10-32 x 1/2" Lg.
31	11	993-15760	EXTERNAL LOCK WASHER, #10
32	1	872-00381	BOARD INSULATION, 1" Th.x 3 5/8" x 72 1/4" LG.
33	1	817-02420	SWITCH, HIGH AIR PRESSURE
34	1	859-00022	TEE, 150# MI., .25"
35	2	857-00726	NIPPLE, .25" SCH.80 X 1.5" LG.
36	1	857-00679	NIPPLE, .25" SCH.80 X 3" LG.
37	1	848-00157	Terminal, Ignition, Straight, Spring Snap, 7mm Cable

20. Burner Assembly 30 HP



Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	132C02500	Insulated Front Door Assembly
2	1	853-00982	Gasket Rope, 1-1/4" Dia x 110" LG.
3	2	380A01034	Gasket Adapter Plate to Door
4	1	380-01030	Burner Canister
5	1	380A01067	Adapter Plate, Blower to Door
6	4	869-00030	Nut, Hex. 3/8"-16 UNC
7	1	380A01037	Gasket, Adapter Plate to Blower
8	1	894-04076	Blower Unit, 115V
9	1	048-00660	Venturi, Air, Gas Premix, C/W Sensing Line
10	2	380A01032	Gasket Electrode (C/W Items #11 and #12)
11	1	380A01031	Electrode, Double
12	1	380A01039	Electrode, Single
13	1	065C00879	Retainer, Sight Port
14	1	851-00026	Sight Glass Pyrex, .1875" x 1.75" LG.
15	2	853-00213	Sight Glass Gasket, .0625" x 1.438" ID x 1.719" OD
16	3	860-00997	Machine Screw, #8-32 UNC x .75" LG.
17	1	857-00679	Nipple, .25" SCH.80 x 3" LG.
18	2	857-00726	Nipple, .25" SCH.80 x 1.5" LG.
19	1	859-00022	TEE, 150# ML, .25"
20	1	817-03468	Combustion Air Proving Switch
21	2	845-00468	Connector, .125" NPT. x .25" OD.
22	1	939-00661	Tubing, Aluminum, .25" OD. x .035" Wall x 25" LG.
23	4	928-00228	Cable Ring Loop, McMaster Carr #7572K17 Self-Closing
24	4	860-00033	Machine Screw, #10-32 UNF x .375" LG.
25	1	507C08078	Piping Gas Train
26	4	869-00036	Nut, Hex. 5/16"-18 UNC
27	1	880C01858	Air Filter Kit, 4"
28	4	952-00145	1/4" Flat Washer
29	1	800-00098	Venturi Gasket
30	4	868-00536	Socket Head Cap Screws, #10-24 UNC x 1" LG.
31	4	869-00061	Nut, Hex Machine Screw, #10-24 UNC
32	4	993-16083	Capscrew, Hex. #10-32 x 1/2" LG.
33	11	993-15760	External Lock Washer, #10
34	1	872-00381	Board Insulation, 1" TH. x 3 5/8" x 91" LG.
35	1	008-03620	Bracket, Junction Box
36	1	817-02420	Switch, High Air Pressure
37	1	848-00157	Terminal, Ignition, Spring Snap, 7mm Cable

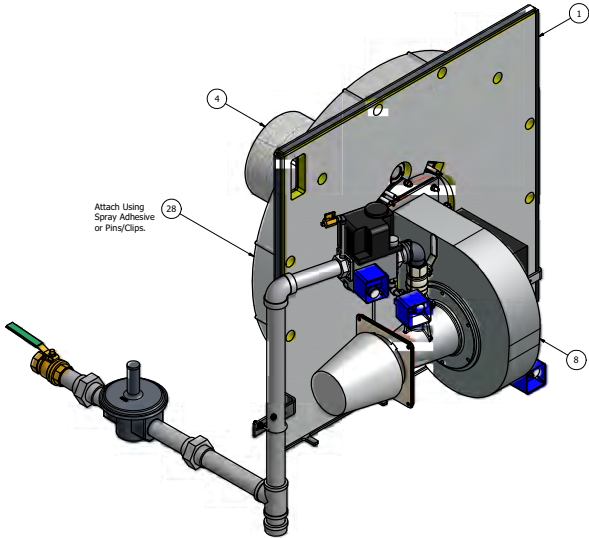
21. Burner Assembly 40 HP



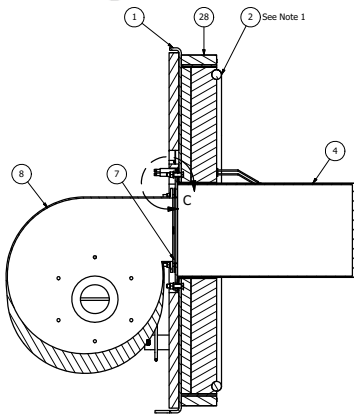
Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	132C02500	INSULATED FRONT DOOR ASSEMBLY
2	1	853-00982	GASKET ROPE, 1-1/4" DIA. X 85" LG.
3	2	380A01034	GASKET, ADAPTER PLATE TO DOOR
4	1	380-01030	BURNER CANISTER
5	1	380A01082	ADAPTER PLATE, BLOWER TO DOOR
6	4	869-00030	NUT, HEX. 3/8"-16 UNC
7	1	380A01076	GASKET, ADAPTER PLATE TO BLOWER
8	1	894-04111	BLOWER UNIT, 115V
9	1	048-00656	VENTURI, AIR, GAS PREMIX, C/W SENSING LINES
10	-	380A01032	GASKET, ELECTRODE, (INCLUDED WITH ITEM# 11,12)
11	1	380A01061	ELECTRODE, DOUBLE, C/W GASKET
12	1	380A01060	ELECTRODE, SINGLE, C/W GASKET
13	1	065C00879	RETAINER, SIGHT PORT
14	1	851-00026	SIGHT GLASS, PYREX, .1875" X 1.75" OD.
15	2	853-00213	SIGHT GLASS GASKET, .0625" X 1.138" X 1.719" OD.
16	3	860-00097	MACHINE SCREW, #8-32 UNC X .75" LG.
17	1	857-00681	NIPPLE, .25" NPT. SCH.80 X 5" LG.
18	1	817-03468	COMBUSTION AIR PROVING SWITCH
19	2	845-00468	CONNECTOR, .125" NPT. X .25" OD
20	1	939-00661	TUBING ALUMINUM, .25" OD X .035" WALL X 34" LG.
21	4	928-00228	CABLE RING LOOP, MCMASTER CARR#7572K17 SELF CLOSING
22	4	860-00033	MACHINE SCREW, #10-32 UNF X .375" LG.
23	1	507C07955	GAS TRAIN PIPING
24	4	869-00036	NUT, HEX.5/16"-18 UNC
25	1	800-00098	VENTURI GASKET
26	1	008C03564	GAS VALVE BRACKET
27	1	841-01122	U-BOLT WITH NUTS
28	4	868-00536	SOCKET HEAD CAP SCREW, #10-24 UNC x 1" Lg.
29	1	880C02005	AIR FILTER KIT, 6"
30	4	952-00145	1/4" FLAT WASHER
31	1	008C03620	BRACKET, JUNCTION BOX
32	4	869-00061	NUT, HEX, MACHINE SCREW, #10-24 UNC.
33	4	993-16083	CAPSCREW, HEX.#10-32 x 1/2" Lg.
34	11	993-15760	EXTERNAL LOCK WASHER, #10
35	1	872-00381	BOARD INSULATION, 1" TH. X 3 5/8" X 91" LG.
36	1	859-00022	TEE, 150# MI. .25" NPT.
37	1	859-00078	ELBOW, 90, .25" NPT. 150# M.I.
38	3	857-00726	NIPPLE, .25" NPT. SCH.80 X 1.5" LG.
39	1	817-02420	HIGH AIR PRESSURE SWITCH
40	1	848-00157	TERMINAL, IGNITION, SPRING SNAP

22. Burner Assembly 50-60 HP

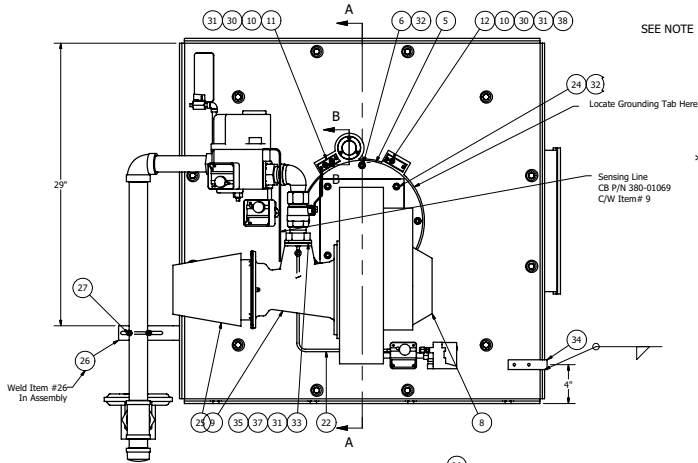
Part No. 750-222



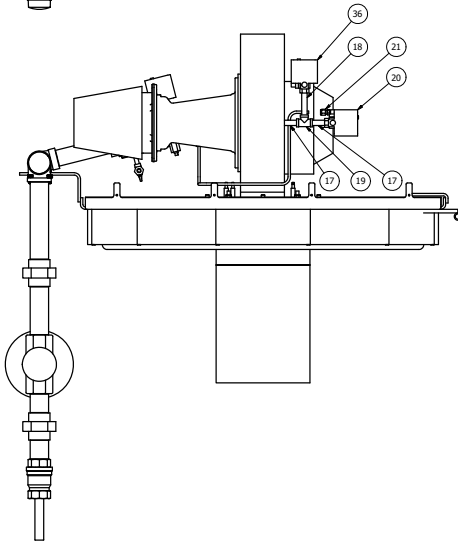
Attach Using
Spray Adhesive
or Pins/Clips.



SECTION A-A



Weld Item #26
In Assembly

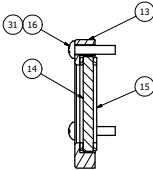


SEE NOTE 1

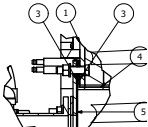
Parts List			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	132C02546	Insulated Front Door Assembly
2	1	853-00982	Gasket Rope
3	2	380A01034	Gasket, Adapter Plate to Vessel
4	1	380-01074	Burner Can Unit
5	1	380A01036	Adapter Plate, Vessel to Blower
6	4	869-00030	Nut, Hex.
7	1	380A01038	Gasket, Adapter Plate to Blower
8	1	894-04075	Blower Unit
9	1	See table	Venturi, C/W Sensing Line
10	2	380A01032	Gasket, Electrode (C/W Items #11 and #12)
11	1	380A01061	Electrode, Dual, Clearfire Ignition
12	1	380A01060	Electrode, Single, Clearfire Flame Rod
13	1	065C00879	Retainer Sight Port
14	1	851-00026	Sight Glass Pyrex
15	2	853-00213	Sight Glass Gasket
16	3	860-00097	Machine Screw
17	2	857-00727	Nipple
18	1	857-00679	Nipple
19	1	859-00022	TEE
20	1	817-03468	Combustion Air Proving Switch
21	2	845-00468	Connector
22	1	939-00661	Tubing, Aluminum
23	1	507C08104	Piping, Gas Train
24	4	869-00198	Nut, Hex
25	1	880C02005	Air Filter Kit Venturi
26	1	008C03564	Gas Train Bracket
27	1	841-01122	U-Bolt
28	1	872-00381	Board Insulation
29	8	952-00133	Washer
30	4	993-16083	Capscrew
31	11	993-15760	External Lock Washer, #10
32	4	952-00145	1/4" Flat Washer
33	4	868-00536	Socket Head Cap Screws
34	1	008C03620	Bracket, Junction Box
35	1	869-00061	Nut, Hex, Machine Screw
36	1	817-02420	Switch, High Air Pressure
37	1	800-00098	Venturi Gasket
38	1	848-00157	Terminal, Ignition, Spring Snap, 7mm Cable

Notes:
1) When Installing Gasket Rope, Compress Rope to Maximize Diameter.

Item 9 - Venturi	50hp	048-00656
	60hp	048-00662

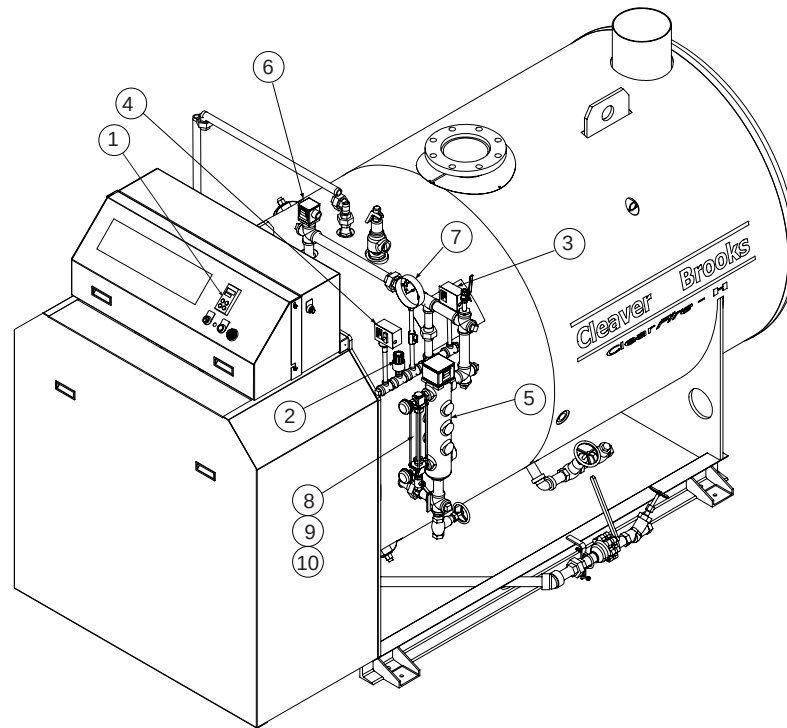


SECTION B-B



DETAIL C

23. Boiler Controls



Item	Description	Component	15# Steam	150# Steam
1	Modulating Controller	RWF40	817-03207	817-03207
2	Modulating Control Sensor	Press. sensor	817-04000	817-03999
3	Operating Limit Controller	Press. Control	817-04095	817-04093
4	High Limit Controller	Press. Control, Manual Reset	817-04094	817-04092
5	LWCO	DF control board	833-03130	833-03130
		Water Column	817-03983	817-03983
6	ALWCO	26 w/ Man. Reset	833-03547	833-03547
		Probe Holder	817-03984	817-03984
7	Pressure Gauge		850-00243	850-00122
8, 9, 10	Sight Glass Kit	Gauge Glass Valve Set	825-00132	825-00132
		Glass, Tubular, Pyrex	851-00199	851-00199
		Gauge Glass Protector Set	912-00085	912-00085

RECOMMENDED SPARE PARTS LIST ClearFire-H

ITEM	10 HP	15 HP	20 HP	25 HP	30 HP	40 HP	50 HP	60 HP
Electrode, Dual, Sparking	380-01061							
Electrode, Single, Ionization	380-01062			380-01060				
Electrode Gasket		380-01032						
Burner Canister	380-01055	380-01045		380-01029	380-01030		380-01056	380-01074
Ignition Cables (2)	826-00156							
Gasket, Venturi	800-00098							
Gaskets, Handhole	853-00934							
Gasket, Burner Door, 1-1/4"	853-00982							
Gasket, Blower Adapter to Blower	380-01037					380-01076	380-01038	
Gasket, Blower Adapter to Door	380-01053			380-01033	380-01034			
Gasket, Burner Canister	380-01053			380-01033	380-01034			
Gaskets, Sight Glass	853-00213							
Burner Sight Glass	851-00026							
Pressure Gauge, 300 psi	850-00122							
Valve Set, Gauge Glass	825-00132							
Gauge Glass, Pyrex	851-00199							
Protector Set, Gauge Glass	912-00085							

APPENDIX A

Gas Valve installation and maintenance

V4730C/V8730C 1:1 Gas/Air Servo Regulated Gas Valves

PRODUCT DATA



NOTE: Photo shows valve with manual safety shutoff valve and venturi installed.

FEATURES

- Wide modulation range (14% to 100% of burner load).
- 24 Vac and 120 Vac models.
- Main valve body with two shutoff seats (double block valve).
- Closing time less than one second.
- Mesh screen (strainer) between inlet flange and main body.
- Various pressure tap points available at main body when no additional valves or pressure switches are used.
- DIN 43650 Plug Connector with 36-in. (914 mm) leadwires included.
- Flexible mounting positions of venturi manifold to fan.
- Replaceable pipe flange adapters available.
- Position indication lamp for each valve stage.

APPLICATION

The V4730C/V8730C 1:1 Gas/Air Servo Regulated Gas Valves, with the addition of the Venturi Mixing Unit (VMU) and dc fan, are used for modulating premix appliances such as gas burners, gas boilers, rooftop units, makeup air units and process applications.

INSTALLATION

When Installing This Product:

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your
3. The installer must be a trained, experienced, flame safeguard technician.
4. After installation is complete, check out product operation as provided in these instructions.

WARNING

Fire or Explosion Hazard. Can cause severe injury, death or property damage.

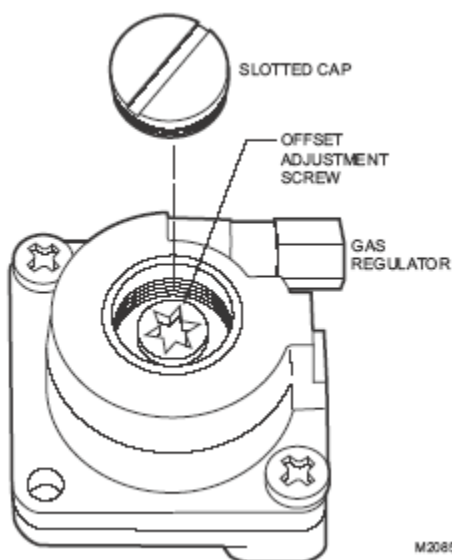
1. Turn off the gas supply before beginning installation.
2. Disconnect power to the valve actuator before beginning installation to prevent electrical shock and damage to the equipment.
3. Do not remove the seal over the valve inlet and outlet until ready to connect piping.
4. The valve must be installed so that the arrow on the valve points in the direction of the gas flow, so that gas pressure helps to close the valve.

Mounting Position

The valve/venturi is factory-calibrated in the upright position for the most accurate metering of the gas flow. This is with the air flow through the venturi in a horizontal direction and the gas flow into the valve in a horizontal direction. The valve can be mounted up to ± 90 degrees from this position without affecting the fuel/air metering at medium and high firing rates (3000 to 5000 rpm of the blower), but at lower firing rates (1000 rpm) the fuel might be reduced up to 10% when the valve is not mounted upright. To counter this, the low fire gas flow may be carefully field adjusted for non-upright mounting as follows:

1. With the valve in the final mounting position, adjust the venturi fan for the lowest burner firing rate.
2. Remove the slotted cap on the gas regulator using a slotted screwdriver. This will expose the offset adjustment screw (see Fig. 1).
3. Using a TORX® T40 or a 5 mm hex wrench, carefully adjust the low fire gas setting for proper combustion.
4. After proper low fire offset adjustment has been made, reinstall the slotted cap on the regulator.
5. Before commissioning the burner, check for proper lightoff and verify correct fuel/air mix and combustion quality throughout the entire firing range (from lowest to highest fan speeds used).

Fig. 1 Regulating Adjusting Screw



Mounting Locations

The distance between the gas valve and the wall/ground must be a minimum of 11-5/16 in. (30 cm).

Main Gas Connection

1. Take care that dirt does not enter the gas valve during handling.
2. Remove the flanges from the valves.
3. Use new, properly reamed, pipe, free from chips.
4. Apply a moderate amount of good quality pipe dope, resistant to the action of liquefied petroleum (LP) gas, only on the pipe threads.
5. Screw the flanges onto the pipes.
6. Do not thread the pipe too far into the flange. Valve distortion or malfunction can result from excess pipe in the flange.
7. Make sure O-ring sealing surfaces are clean.
8. Using general purpose lithium grease, grease the O-ring.
9. Install the O-ring into the O-ring groove provided on the valve body (one O-ring per groove).
10. Mount the gas valve to the flanges, using the screws removed earlier.
11. Complete the electrical connections as instructed in the Electrical Connections section.

WARNING

Fire or Explosion Hazard. Can cause severe injury, death or property damage.

Perform a soap-and-water solution gas leak test any time work is done on a gas system.

Electrical Connections

Wiring

1. Use 14, 16 or 18 AWG copper conductor, 600 volt insulation, moisture-resistant wire for line voltage connections. Recommended wire types are TTW60C, THW75C or THHN90C.
2. Follow the instructions below for wiring the gas valve. See Fig. 2 and 3 for reference.
 - a. T1 (yellow) will be L2 (120 Vac or 24 Vac).
 - b. T2 (black) will be L1 (120 Vac or 24 Vac) to Valve 1.
 - c. T3 (blue) will be L1 (120 Vac or 24 Vac) to Valve 2.
 - d. Ground (green) will be earth ground.

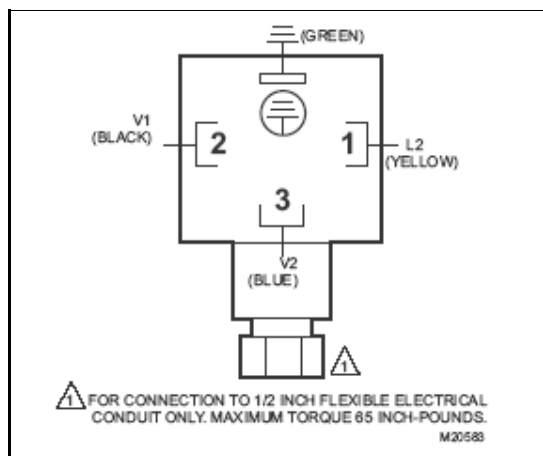


Fig. 2 Four-Pin Electrical Plug Connector

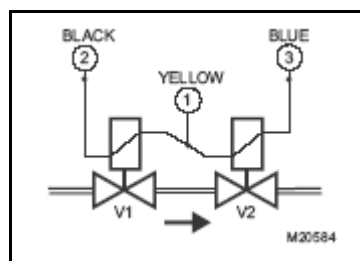
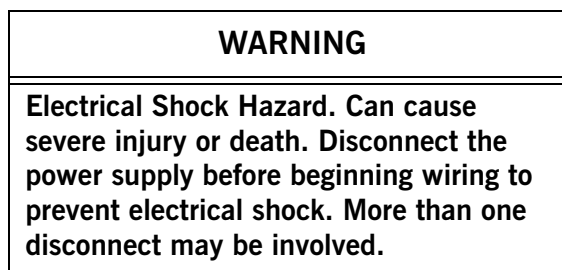


Fig. 3 Electrical Connection Diagram

ADJUSTMENTS AND FINAL CHECKOUT

The following procedures are related to the adjustments on the main gas valve. For adjustments of the other devices (i.e., pressure switches), refer to the instructions supplied with the applicable device.

WARNING

Fire or Explosion Hazard. Can cause severe injury, death or property damage. Only fully qualified, experienced, flame safeguard technicians should make adjustments on the valve.

Pressure Tap Points (Fig. 4)

The V4730C/V8730C Valves have a number of connection points (1/8 in. [3 mm] NPT plugs) for measuring pressure and/or mounting a pressure switch. The pressure tap points are:

- 1** inlet pressure at first SSOV flange tap.
- 2** inlet pressure at first SSOV.
- P** outlet pressure at first SSOV.
- 3** inlet pressure at second SSOV.
- 4** outlet pressure at second SSOV flange tap.

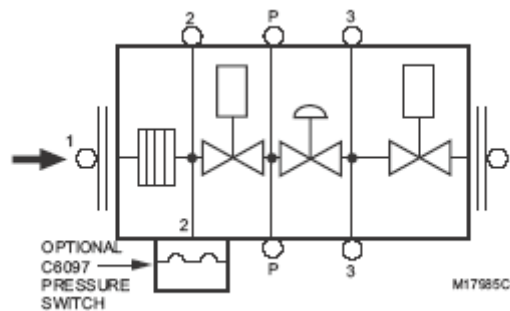


Fig. 4 Pressure Tap Points

The following pressures can be measured:

- 1.** Inlet pressure. tap on inlet flange (**1**).
- 2.** Pressure after inlet screen (**2**).
- 3.** Unregulated intermediate pressure. pressure between the two shutoff seats (**P**).
- 4.** Regulated intermediate pressure. pressure between the shutoff valves (**3**).
- 5.** Outlet pressure. tap from flange (**4**).

The corresponding numbers (**2**, **P**, **3**) can be found on the side of the valve.

NOTE: To mount the C6097 Pressure Switch, refer to instructions in form number 65-0237, furnished with the switch. The pressure switch can be mounted to **2**, **P**, or **3** on either side of the valve.

Second Valve, Fast Opening

Flow rate is adjusted from 0% to 100% of full rated flow. To adjust the flow rate:

- 1.** Remove the flat, round, blue plastic cap from the cover. Using a 3 mm (7/64 in.) hex wrench, turn the adjustment screw counterclockwise to increase or clockwise to decrease the flow rate.
- 2.** Snap the flat, round, blue plastic cap back onto the cover.

Final Checkout of the Installation

Set the system in operation after any adjustment is completed and observe several complete cycles to

ensure that all burner components function correctly.

OPERATION

The V4730C/V8730C are normally closed valves. The valves open when energized and close when power is removed.

WARNING

Explosion and Electrical Shock Hazard. Can cause severe injury, death or property damage.

1. Do not put the system into service until you have satisfactorily completed the Valve Leak Test, all applicable tests described in the Checkout section of the instructions for the flame safeguard control, and any other tests required by the burner manufacturer.
2. All tests must be performed by a trained, experienced, flame safeguard technician.
3. Close all manual fuel shutoff valves immediately if trouble occurs.

After the installation is complete, cycle the valve several times with the manual fuel shutoff valve cock closed. Make sure the valve functions properly. Also, perform the Valve Leak Test before putting the valve into service.

Valve Leak Test (Fig. 5)

This is a test for checking the closure tightness of the gas shutoff valve. It should be performed only by trained, experienced, flame safeguard technicians during the initial startup of the burner system or whenever the valve is replaced. It is recommended that this test should also be included in the scheduled inspection and maintenance procedures. For a periodic inspection test, follow steps 1, 3, 4, 5, 8, 9, 10, 12, 13, 16, and 17.

WARNING

Electrical Shock Hazard. Can cause severe injury or death.

Remove the power from the system before beginning the valve leak test to prevent electrical shock. More than one disconnect may be involved.

1. De-energize the control system to make sure no power goes to the valves.
2. Close the upstream manual gas cock (A).
3. Make sure the manual test petcock (F) is closed in the leak test tap assembly.
4. To test the first SSOV, remove the 1/8 in. (3mm) NPT plug from pressure tap point P.
5. Install the leak test tap into pressure tap point P on the valve body.
6. Open the upstream manual gas cock (A) to re-pressurize the first SSOV.
7. Immerse the 1/4 in. (6 mm) tube vertically 1/2 in. (13 mm) in a jar of water.

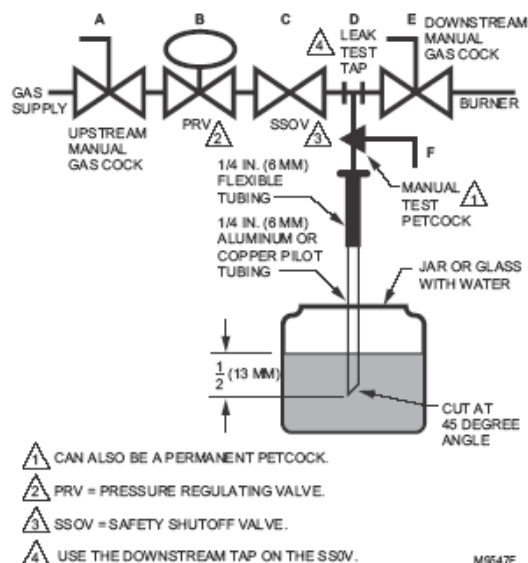


Fig. 5 Valve Leak Test

8. Slowly open the manual test petcock (**F**).
9. When the rate of bubbles coming through the water stabilizes, count the number of bubbles appearing during a ten-second period. Each bubble appearing represents a flow rate of 0.001 cfh (28 cch). See Table 4.
10. Close the upstream manual gas cock (**A**).
11. Remove the leak test tap from the valve body.
12. Using a small amount of pipe sealant on the 1/8 in. (3 mm) NPT plug, reinstall the plug in pressure tap point **P**.
13. To test the second SSOV, remove the 1/8 in. (3 mm) NPT plug from the flange pressure tap point **4**.
14. Install the leak test tap into pressure tap point **4**.
15. Close the downstream manual gas cock (**E**).
16. Immerse the 1/4 in. (6 mm) tube vertically 1/2 in. (13 mm) into a jar of water.

Pipe Size (in. NPT)	Maximum Seat Leakage (UL)	Maximum Number of Bubbles in 10 seconds
1/2 - 3/4	235 cch	6
1	275 cch	7
1-1/4	340cch	8

Table 1. Maximum bubbles per pipe size

17. Slowly open the manual test petcock (**F**).
18. When the rate of bubbles coming through the water stabilizes, count the number of bubbles appearing during a ten-second period. Each bubble appearing during a 10-second period represents a flow rate of 0.001 cfh (28 cch). See Table 1.
19. Remove the leak test tap from the valve body.
20. Using a small amount of pipe sealant on the 1/8 in. (3 mm) NPT plug, reinstall the plug in pressure tap point **4**.

After the Test

1. Make sure the downstream manual gas cock (**E**) is closed.
2. Open the upstream manual gas cock (**A**) and energize the valve through the safety system.
3. Test with rich soap and water solution to make sure there is no leak at the test tap (**D**) or any pipe adapter/valve mating surfaces.
4. De-energize the valve (**C**).
5. Open the downstream manual gas cock (**E**).
6. Restore the system to normal operation.

TROUBLESHOOTING

WARNING

Electrical Shock Hazard. Can cause severe injury, death or property damage.
--

Use extreme caution when troubleshooting; line voltage is present.

IMPORTANT

Do not replace the valve until all other sources of trouble are eliminated.

Troubleshooting Procedure

If the valve does not open when the thermostat or controller calls for heat:

1. Check for voltage at the valve leadwires or terminal block.
2. If there is no voltage at the valve leadwires or terminal block, make sure:
 - a. voltage is connected to the master switch.
 - b. master switch is closed and overload protection (circuit breaker, fuse, or similar device) has not opened the power line.
3. If there is still no voltage at the valve leadwires or terminal block, make sure all appropriate contacts in the thermostat or controller, limits and flame safeguard control are closed. If one or more are open, determine the cause(s); correct the trouble and proceed.
4. If there is proper voltage at the valve but the valve still does not open, check for normal gas pressure.
5. If the valve still does not open, replace the valve.

If the valve does not close when one or more of the appropriate contacts in the thermostat, controller, limits or flame safeguard control is open:

1. Make sure the valve is wired in the correct circuit.
2. Open the master switch to remove power from the valve.
3. If the valve closes now, check the wiring for the valve and correct the wiring as necessary.
4. Check for a short in the electrical circuit and repair it as necessary.

SERVICE INFORMATION

WARNING

Explosion Hazard and Electrical Shock Hazard. Can cause severe injury, death or property damage.

Turn off gas supply and disconnect all electrical power to the valve before servicing.

IMPORTANT

Only trained, experienced, flame safeguard technicians should attempt to service or repair flame safeguard controls and burner assemblies.

Scheduled Inspection and Maintenance

Set up and follow a schedule for periodic inspection and maintenance, including the burner, all other controls and the valves. It is recommended that the valve leak test in the Checkout section be included in this schedule. Refer to the instructions for the primary safety control(s) for more inspection and

maintenance information.

Screen/Strainer Replacement

1. Make sure the gas supply is turned off and all electrical power has been removed.
2. Remove bolts/nuts from flange/valve.
3. Remove flange from gas supply pipe.
4. Remove old screen/strainer.
5. Clean the strainer by using compressed air, or replace the strainer.
6. Install the cleaned strainer or new strainer.
7. Make sure O-ring sealing surface is clean on the flange.
8. Using general purpose lithium grease, grease the O-ring.
9. Apply a moderate amount of good quality pipe dope, resistant to the action of LP gas, only on the pipe threads.
10. Install the O-ring in the O-ring groove provided on the flange/valve body (one O-ring per groove).
11. Screw the flange onto the pipe.
12. Mount the gas valve to the flange, using the bolts and nuts for each flange.
13. Apply power to the valve.
14. Turn on the main gas supply.
15. Complete the valve leak test.
16. Return the valve to service.

APPENDIX B

RWF40 Modulating Controller

User Hints

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1. Introduction to hints manual

1.1.1 How to use this manual

This RWF40 hint manual is intended to *supplement* the RWF40 User Manual.

Please read the RFW40 User Manual before applying power to the controller.

1.1.2 Symbols used in this manual



These symbols represent the four buttons on the controller.
If a combination of keys is required an explanation will be given.



This symbol is used to draw your attention to a particular remark.



This symbol indicates a reference to the RWF40 user manual.

2. Hints

2.1 Getting started with the RWF40 menu

The RWF40 menu system has three Levels, beyond the **Basic Display**, the **User Level**, the **Parameter Level** and the **Configuration Level**.

⇒ RWF40 user manual Section 6 Operation.

2.1.1 Start with the Basic Display

Shown at the right is the basic display.

The upper, larger, 4 digit **red** LEDs, (**180**) will be referred to as, the 'Actual value display'.

The lower, smaller, 4 digit **green** LEDs, (**180**) will be referred to as, the 'Setpoint display'.

☞ The current configuration of your specific controller will determine which levels you will be allowed to access.

C112 must be xxx0 to access the configuration level.

⚠ **The C112 locking code can only be adjusted by the manufacturer.**

☞ All controllers will return to the basic display automatically, if no key is pressed for 30 seconds.

The RWF40 configuration codes (C111, C112, and C113) are all four digits.

The x's used in the explanations in this manual represent a 'don't care' digit in the code, so, xxx0 could mean 1000, 2100, 5430, etc, and we are only concerned with the 'non-x' digits.

C112 code summary :

C112 code	xxx0	Locks nothing
C112 code	xxx1	Locks the Configuration Level
C112 code	xxx2	Locks the Parameter Level
C112 code	xxx3	Locks all levels and keys

2.1.2 User Level

From the basic display, you may advance to the user level, by pressing **PGM** and releasing it.

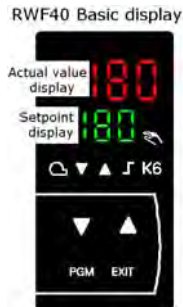
The actual value display, (**180**) shows the setpoint you are adjusting or viewing.

The setpoint display, (**SP 1**) shows the parameter you are adjusting or viewing.

You can adjust the values, within limits, for SP1, SP2, dSP, view tA, SP.E, depending on your specific configuration.

To adjust user level values, please see the "4 How to change a setpoint",

or ⇒ RWF40 user manual Section 6.2.1.



2.1.3 Parameter Level

From the user level you may advance to the parameter level, by pressing **PGM** and holding, for 3 seconds, and then releasing it.

☞ C112 must be xxx0 or xxx1, to access this level.

The actual value display, (**0**) shows the parameter's actual value.

The setpoint display, (**AL**) shows the parameter you are adjusting or viewing.

You can adjust the values for AL, Hyst, Pb.1, dt, rt, HYS.1, HYS.2, HYS.3, q, H, and P, depending on your specific configuration.

To adjust parameter values, please see "3 How to adjust parameters",

or ⇒ RWF40 user manual Section 7.



2.1.4 Configuration Level

From the parameter level you may advance to the configuration level, by pressing **PGM** and holding, again for 3 seconds, and then releasing it.

☞ C112 must be xxx0 to access this level.

The actual value display, (**9030**) shows the configuration item's actual value.

The setpoint display, (**C111**) shows the configuration item you are adjusting.

You can adjust the values, within limits, for C111, C112, C113, SCL, SCH, SCL2, SCH2, SPL, SPH, OFF1, OFF2, OFF3, and dF1 depending on your specific configuration.

To adjust configuration values, please see the "2 How to configure our RWF40",

or ⇒ RWF40 user manual Section 8.



Return to the Basic Display

You may exit any level, and return to the basic display at any time, in two ways.

First, to exit immediately, press **EXIT** and release it.

The second way is to simply wait 30 seconds, and the controller will automatically return to the basic display.



2. Hints

2.2 How to configure your RWF40

Shown at the right is the basic display.

The current configuration of your specific controller will determine which levels you will be allowed to access.

C112 must be xxx0 to access the configuration level.

⚠ The C112 locking code can only be adjusted by the manufacturer.

To reach the configuration level, you start from the basic display, (shown above), skip past the user level, and go first, to the parameter level, and then, finally, to the configuration level.

Press **PGM** and hold for 3 seconds, and then release it.

You are now at the parameter level.

From the parameter level you may now advance to the configuration level,

by pressing **PGM** again, holding, for 3 seconds, and then releasing it.

The actual value display, (9030) shows the current configuration value.

The setpoint display, (C111) shows the configuration item you are adjusting.

Configuration level items summary :

C111	Analog input 1 Analog input 2 Analog input 3 D2 function	sensors (14 types), standard signal none, external SP, analog SP Shift none, outdoor sensors ... none, SP chg/over, SP binary shift
C112	Limit comparator Controller type Setpoint SP1 Locking	none, input 1,2,3 ... 3-position, modulating 0-20mA, ... via buttons, with outside sensor none, configuration, parameters, buttons
C113	Unit address Unit address Decimal - Units Signal out-of-range	0-9 0-9 ° C or ° F and decimals limit comparator OFF/ON

SCL **Scale Low** Analog input 1
SCH **Scale High** Analog input 1

SCL2 **Scale Low** Analog input 2
SCH **Scale High** Analog input 2

SPL **Set Point, Lower**
SPH **Set Point, Higher**

OFF1 Actual value correction, **OFF**set, Analog input 1
OFF2 Actual value correction, **OFF**set, Analog input 2
OFF3 Actual value correction, **OFF**set, Analog input 3

Df1 Digital filter time constant for Analog input 1

Example Re-configure (adjust) the value for C111

If no keys are pressed for 30 seconds, at anytime, the controller will automatically return to the basic display.

The current value of **C111**, (9030) is shown in the actual value display.

The current configuration item (C111) is shown in the setpoint display.

The display is steady, (not flashing) and by default, the 4th, (rightmost) digit is the one you may now adjust.

You can select the digit you want to adjust, by pressing **▼** once and releasing it.

The 3rd digit is now flashing, indicating that it is now, the adjustable digit.

(Each time you press and release **▼** you cycle, thru each digit, right-to-left and back again)

To change the value of the flashing digit, press **▲** and release it.

Each time you press **▲** and release, you cycle up thru the allowable values, and back again.

Once you have the desired value displayed and flashing, you may accept it by pressing **PGM** once and releasing it.

All four upper digits will flash once.

The controller displays the new configuration values, in 4 steady digits.

Your options at this point are:

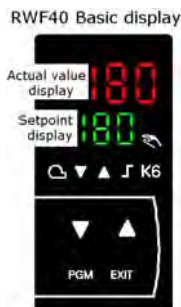
Press **EXIT** and release, to immediately return to the basic display. or

press **PGM** and release it, to advance to C112,
press **PGM** again and release it, to advance to C113,
press **PGM** and release it, to advance to SCL,
... after the last configuration item Df1,

press **PGM** and release it, to advance to AL, (the 1st parameter),
... after the last parameter item P,

press **PGM** and release it, to advance to SP1, (the 1st user item),
... after the last user item it cycles back to the 1st user item.

Or simply wait 30 seconds and the controller will automatically return to the basic display.



2. Hints

2.3 How to adjust parameters

⇒ RWF40 user manual Section 6.3

Shown at the right is the basic display.

The current configuration of your specific controller will determine which levels you will be allowed to access.

C112 must be xxx1 or xxx0 to access the parameter level.

⚠ The C112 locking code can only be adjusted by the manufacturer.

From the basic display, you may skip the user level, to reach the parameter level.

Press **PGM** and hold, for 3 seconds, and release.

The actual value display, (0) shows the current parameter value.

The setpoint display, (AL) shows the parameter item you are adjusting.

Parameter level items summary:

AL	Alarm Limit value for comparator
HYS1	Switching differential, Hys teresis 1 , 2-stage burner
Pb.1	Proportional b and 1
dt	derivative t ime
rt	Integral action t ime
db	* dead b and, contact spacing
tt	* Actuator running t ime
HYS1	Switch-on threshold, Hys teresis 1 , 2-stage burner
HYS2	Switch-off threshold, Hys teresis 2 , 2-stage burner
HYS3	Switch-off threshold, Hys teresis 3 , upper
q	Response threshold
H	Heating curve slope
P	Parallel displacement

* Items are only displayed when controller is configured for a 3-position output.

Example Adjust the value for parameter AL.

If no keys are pressed for 30 seconds, at anytime, the controller will automatically return to the basic display.

The current value of AL, (0) is shown in the actual value display.

The current parameter item (AL) is shown in the setpoint display.

The display is steady, (nothing is flashing) and the value for AL can now be adjusted.

You can decrease the value by pressing **▼** and releasing it.



You can increase the value by pressing **▲** and releasing it.



You can accept the change by waiting 2 seconds.



The red LED's will blink once, and become the new value.

Or, you can advance to the Next parameter by pressing **PGM** once and releasing it.



HYS1 can be adjusted the same way you just did AL.

Your options at this point are:

Press **EXIT** and release, to immediately return to the basic display.

Press **PGM** and release it, to advance down to Pb.1, (the next parameter).

... after the last parameter item P, press **PGM** and release it, to advance down to SP1, (the 1st user item).

... after the last user item, the menu cycles back to the 1st user item.

Or simply wait 30 seconds and the controller will automatically return to the basic display.

2. Hints

2.4 How to change a setpoint

(SP1, SP2, or dSP)

⇒ RWF40 user manual Section 6.2

Shown at the right is the basic display.

The current configuration of your specific controller will determine which levels you will be allowed to access.

C112 must be xxx2, xxx1, or xxx0 to access the parameter level.

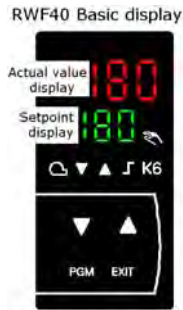
 **The C112 locking code can only be adjusted by the manufacturer.**

From the basic display, you may skip the user level, to reach the parameter level.

Press **PGM** and hold, for 3 seconds, and release.

The actual value display, (0) shows the current parameter value.

The setpoint display, (AL) shows the parameter item you are adjusting.



Parameter level items summary:

AL	Alarm Limit value for comparator
HYSt	Switching differential, Hysteresis for limit comparator
Pb.1	Proportional band 1
dt	derivative time
rt	Integral action time
db	* dead band, contact spacing
tt	* Actuator running time
HYS1	Switch-on threshold, Hysteresis 1, 2-stage burner
HYS2	Switch-off threshold, Hysteresis 2, 2-stage burner
HYS3	Switch-off threshold, Hysteresis 3, upper
q	Response threshold
H	Heating curve slope
P	Parallel displacement

* items are only displayed when controller is configured for 3-pos output.

Example Adjust the value for parameter AL.

 If no keys are pressed for 30 seconds, at anytime, the controller will automatically return to the basic display.

The current value of **AL**, (0) is shown in the actual value display.

The current parameter item (**AL**) is shown in the setpoint display.

The display is steady, (nothing is flashing) and the value for AL can now be adjusted.



You can decrease the value by pressing  and releasing it.



You can increase the value by pressing  and releasing it.



You can accept the change by waiting 2 seconds.



The red LED's will blink once, and become the new value.

Or, you can advance to the next parameter by pressing **PGM** once and releasing it.



HYS1 can be adjusted the same way you just did AL

Your options at this point are:

Press **EXIT** and release, to immediately return to the basic display.

Press **PGM** and release it, to advance down to Pb.1, (the next parameter).

... after the last parameter item P, press **PGM** and release it, to advance down to SP1, (the 1st user item).

... after the last user item, the menu cycles back to the 1st user item.

Or simply wait 30 seconds and the controller will automatically return to the basic display.

2. Hints

2.5 How to display the software version and units

⇒ RWF40 user manual Section 6.2 .5

Shown at the right is the basic display.

The current configuration of your specific controller will determine which levels you will be allowed to access.

A C112 of xxx3 will prevent use of the keys.

⚠ The C112 locking code can only be adjusted by the manufacturer.

You can display the software version, and units, of your controller, at any time, by pressing the **PGM + ▲** at the same time, and holding them...

You will see one, of the three displays shown below.



The software version of your controller, (Version **102** in this example.) is shown in the actual value display.

The current units configuration (°C, °F, or %) is shown in the setpoint display.

The display will return, to the where it was, *if you release the keys at the same time*, if not, you will return back to the basic display.

Configure Codes \ Units summary:

°C will be displayed if your controller is configured with:

C111	0xxx .. dxxx	Analog input 1	Sensor (Pt100, Ni100, ..)
C113	xx0x	No decimals	°C
C113	xx1x	One decimal	°C

°F will be displayed if your controller is configured with

C111	0xxx .. dxxx	Analog input 1	Sensor (Pt100, Ni100, ..)
C113	xx2x	No decimals	°F
C113	xx3x	One decimal	°F

% will be displayed if your controller is configured with:

C111	Exxx .. Hxxx	Analog input 1	Standard input (4-20mA, ..)
C113	xx0x .. xx3x		Doesn't matter

RWF40 Basic display



2.6 Manual operation

⇒ RWF40 user manual Section 6.2 .2 and 6.2.3.

Shown at the right is the basic display.

The current configuration of your specific controller will determine which levels you will be allowed to access.

A C112 of xxx3 will prevent use of the keys.

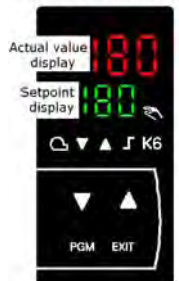
⚠ The C112 locking code can only be adjusted by the manufacturer.

Manual operation can *only* be performed when the thermostat function is active and burner is released to modulation.

The **green** burner LED must be on, relay 1 is energized, and the contact, Q13 N.O. - Q14 Com, is closed.

If at any time the burner LED turns off, the controller will exit the manual operation function.

RWF40 Basic display



2. Hints

2.6 Manual operation continued...

Modulating burner, 3-Position output

Press **EXIT** and hold for 5 seconds, and release.

The **red** LED above the manual icon turns on to indicate that the controller is now in the manual mode.

Relay 2 and relay 3 will hold their current state, (energized or de-energized) that they were in until another key is pressed.



When the **▼** is **pressed**:

- Relay 3 is **energized**
- Decrease icon **turns on**
- N.O. contact Q-Y2 **closes**, to drive the modulating device **down**, which **decreases** the firing rate of the burner.



When the **▼** is **released**:

- Relay 3 is **de-energized**
- Decrease icon **turns off**
- N.O. contact Q-Y2 **opens**, to hold the modulating device **where it is**, which **holds** the firing rate of the burner.



When the **▲** is **pressed**:

- Relay 2 is **energized**
- Increase icon **turns on**
- N.O. contact Q-Y1 **closes**, to drive the modulating device **up**, which **increases** the firing rate of the burner.



When the **▲** is **released**:

- Relay 2 is **de-energized**
- Increase icon **turns off**
- N.O. contact Q-Y1 **opens**, to hold the modulating device **where it is**, which **holds** the firing rate of the burner.

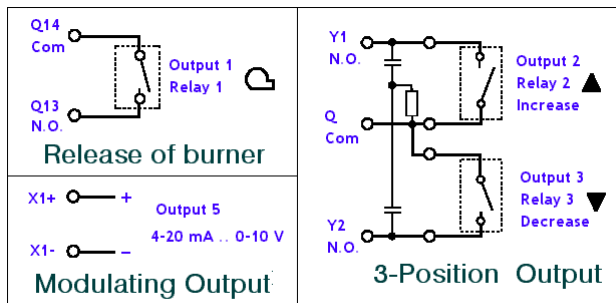


Figure 1 Connection diagrams

Modulating burner, Modulating output

Press **EXIT** and hold for 5 seconds, and release.

The red LED above the manual icon turns on to indicate that the controller is now in the manual mode.

Relay 2 and relay 3 will hold their current state, (energized or de-energized) that they were in until another key is pressed.



By design, the 0 output starts driving the modulating device to low fire, but if you promptly press the **▲** after the red LED above the hand icon turns on, you can prevent the from going all the way.

When the **▼** is **pressed**,

- the output value **starts increasing**, and the output, to terminals X1+ and X1- **starts increasing**, the same amount, and **increases** the firing rate of the burner.



When the **▼** is **released**,

- output value, **stops increasing**, and the output, to terminals X1+ and X1- **also stops increasing**, and **holds** the current firing rate of the burner.



When the **▲** is **pressed**,

- the output value **starts decreasing**, and the output, to terminals X1+ and X1- **starts decreasing**, the same amount, and **decreases** the firing rate of the burner.



When the **▲** is **released**,

- output value, **stops decreasing**, and the output, to terminals X1+ and X1- **also stops decreasing**, and **holds** the current firing rate of the burner.



To exit manual operation

Press **EXIT** for 5 seconds, and release.

The red LED above the hand symbol turns off, and the controller returns to the automatic mode.

On Modulating burners, with modulating output, the output to terminals X1 and X2, also returns to automatic operation.

On Modulating burners, with 3-position output, the output to relay 2 and relay 3, also returns to automatic operation.



2. Hints

2.7 Auto-tune (self-setting function)

⇒ RWF40 user manual section 6.2.4 and 9.1

The RWF40 User manual refers to a 'self-setting-function' that for the purposes of this manual will be referred to as 'Auto-tune'.

Technical Explanation

Auto-tune is a self-setting software function, that is integrated into the RWF40 controller, and can be repeated as often as desired.

Auto-tune tests the reaction, in the modulating mode of operation, of the process-control loop, to steps in the actuator position, according to a special procedure.

The data, during the forced oscillations, is then recorded, and used to calculate new values, that are optimized for your specific controlled system.

Auto-tune items summary:

Items at the user level that will affect **Auto tune**

- SP 1** Set Point 1
- HYS1** Switch-on threshold, **HYS**teresis 1
- HYS3** Switch-off threshold, **HYS**teresis 3,

Items at the Parameter level that **Auto-tune** will adjust

- Pb.1** Proportional band 1 (Factory setting 10)
- dt** derivative time (Factory setting 80)
- rt** Integral action time (Factory setting 350)

Item at the configuration level that **Auto-tune** will adjust

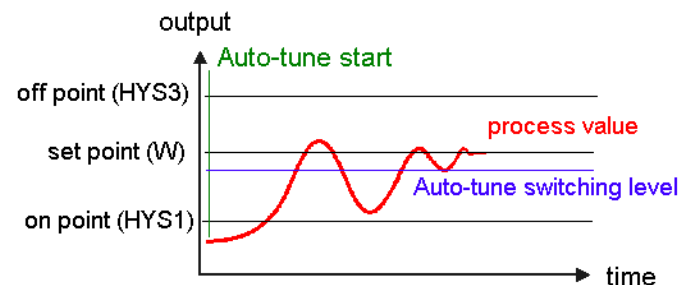
- df1** Time constant for digital Filter, analog 1

Values for **Pb.1**, **dt**, **rt** and **df1**, can always be changed.

Auto-tune uses **two different methods** to force oscillations, and will **automatically select and use**, a method, based on, at the start of **Auto-tune**, what the **difference** is, between the **setpoint (w)**, and the **process value**.

When **Auto-tune** is started with a **large difference**, (typically *before* the process-control loop has stabilized) **Auto-tune** performs a forced oscillation around a **switching level**.

When **Auto-tune** is started with a **small difference**, (typically *after* the process-control loop has stabilized) **Auto-tune** performs a forced oscillation, around the **setpoint (w)**.



If for any reason the controller exceeds the switch off threshold (HYS3) **Auto-tune** will be cancelled.

Conditions

The controller must be :

- in the modulating output mode (D1 is open and the step icon  is off)
- burner is released (green LED above  is on, relay 1, is activated, contact between terminals Q14 and Q13 is closed)
- controller is not in manual mode (red LED above  is off)

Procedure

Start **Auto-tune** by pressing **PGM**+**▼** and release.

The current temperature value, (175) is shown in the actual value display.

The current function item (**tunE**) is flashing in the setpoint display.

You can cancel **Auto-tune** while it is flashing pressing **▲** and releasing.

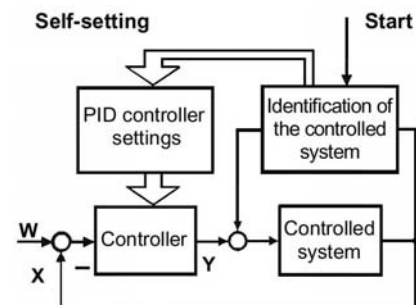
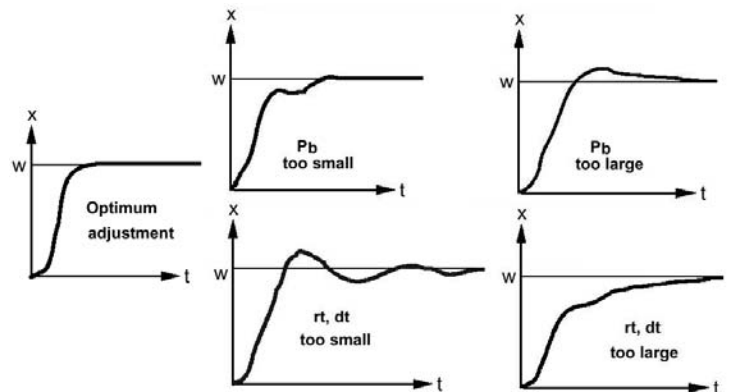


When **tunE** stops flashing on it's own **Auto-tune** is complete.

You can save the new values for **Pb.1**, **dt**, **rt** and **df1**, by pressing **▲**, and holding for at least 2 seconds.



Possible results, and their correction. A favorable value for dt is rt/4.



Block diagram of Auto-tune.

2. Hints

2.8 Setting up a standard temperature application

Using a 1000 ohm Ni RTD,
L & S # 556-541 -13 °F to +203 °F

Configure

If no keys are pressed for 20 seconds, the controller will exit this mode, and return to the basic display.

See Hint section 2.2, 'How to configuration your RWF40'.

(From the basic display, or user level,

press **PGM** and hold, for 3 seconds,
and then release, and again,

press **PGM** and hold, for 3 seconds,
and then release)

The actual value display, (9030)
shows the current configuration item *value*.

The setpoint display, (C111)
shows the configuration *item* you are adjusting.

The display is steady, (not flashing) and by default,
the 4th, (rightmost) digit may now be adjusted.

You can select which digit you wish to adjust, by
pressing **▼** once and releasing it. The 3rd digit is now
flashing, indicating that it is now, the adjustable digit.

Cycle thru each digit of C111 and configure as charted
below, then accept by pressing **PGM** and releasing.

All four upper digits will flash once, and the new
configuration value, is displayed in 4 steady digits.

Press **PGM** and release, to configure C112, C113, ... thru Df1.

Configuration level values:

Item	Description	Value	* Sec
C111		9000	
	Analog input 1	9	Landis & Staefa Ni 1000 8.1
	Analog input 2	0	None 8.1
	Analog input 3	0	None 8.1
	D2 function	0	None 8.1
C112		8200	
	Limit comparator	8	input 1 8.1
	Controller type	2	modulating 4-20mA 8.1
	Setpoint SP1	0	via buttons 8.2
	Locking	0	None 8.2
C113		0220	
	Unit address	02	Modbus address 8.2
	Decimal - Units	2	(%) no decimals 8.2
	Out-of-range Signal	0	limit comparator OFF 8.2
SCL	SCale Low	0	Analog input 1 8.3.1
SCH	SCale High	100	Analog input 1 8.3.2
SCL2	SCale Low	0	Analog input 2 8.3.3
SCH2	SCale High	100	Analog input 2 8.3.4
SPL	SetPoint Low	160	limits low setpoint to 160 °F 8.3.5
SPH	SetPoint High	205	limits high setpoint to 205 °F 8.3.6
OFF1	Actual value correction	0	Analog input 1 8.3.7
OFF2	Actual value correction	0	Analog input 2 8.3.8
OFF2	Actual value correction	0	Analog input 3 8.3.9
Df1	Digital filter time constant	0	Analog input 1 8.3.10

Set parameters

See Hint section 2.3, 'How to adjust parameters'

The actual value display, (0)
shows the current parameter *value*.

The setpoint display, (AL)
shows the parameter *item* you are adjusting.

Increase **▲** or decrease **▼** the value,
accept it by waiting 2 seconds.

Once it flashes, proceed to the next parameter
(HYSt) by pressing **PGM** and releasing.

Adjust all of the parameters as shown below.

Parameter level values:

Value	Item	Description	* Sec
160	AL	Limit value for comparator	8.2
5	HYSt	Switching differential for limit comparator	8.2
10	Pb.1	SPE setpoint external	9.2
80	dt	Derivative time	9.2
350	rt	Integral action time	9.2
-5	HYS1	Burner-on 5 °F below setpoint	5.5.1
3	HYS2	Burner-off, 2-stage	5.2.3
5	HYS3	Burner-off 5 °F above setpoint	5.5.1
0	q	Response threshold	5.6
1	H	Heating curve slope	5.5.1
0	P	Parallel displacement	5.5

Set user level values

See Hint section 3.4, 'How to change a setpoint'.

You may enter the user level, directly from
the basic display.

Press **PGM** and release.

The actual value display, (180)
shows the current user level item *value*.

The setpoint display, (SP 1)
shows the user level *item* you are adjusting.

Increase **▲** or decrease **▼** the value, accept it by
waiting 2 seconds. Once it flashes,
press **PGM** and release.

Adjust SP1 as shown below.

User level values:

Value	Item	Description	* Sec
180	SP 1	Set point 1	5.5.1

Setup is complete!

* Sec Refers to the RWF40 user manual section.



2. Hints

2.9 Setting up a standard pressure application

Using a QBE sensor,
Siemens part # QBE620-P10 [P10 is 150PSI]

Configure

If no keys are pressed for 20 seconds, the controller will exit this mode, and return to the basic display.

See Hint section 2.2, 'How to configuration your RWF40'.

(From the basic display, or user level,

press **PGM** and hold, for 3 seconds,
and then release, and again,
press **PGM** and hold, for 3 seconds,
and then release)

The actual value display, (9030)
shows the current configuration item value.

The setpoint display, (C111)
shows the configuration item you are adjusting.

The display is steady, (not flashing) and by default,
the 4th, (rightmost) digit may now be adjusted.

You can select which digit you wish to adjust, by
pressing **▼** once and releasing it. The 3rd digit is now
flashing, indicating that it is now, the adjustable digit.

Cycle thru each digit of C111 and configure as charted
below, then accept by pressing **PGM** and releasing.

All four upper digits will flash once, and the new
configuration value, is displayed in 4 steady digits.

Press **PGM** and release, to configure C112, C113, ... thru Df1.

Configuration level values:

Item	Description	Value	* Sec
C111		G000	
	Analog input 1	9	Std Signal 0-1VDC 8.1
	Analog input 2	0	none 8.1
	Analog input 3	0	none 8.1
	D2 function	0	none 8.1
C112		8200	8.1
	Limit comparator	8	input 1 8.1
	Controller type	2	modulating 4-20mA 8.1
	Setpoint SP1	0	via buttons 8.2
	Locking	0	none 8.2
C113		0220	
	Unit address	02	Modbus address 8.2
	Decimal - Units	2	(%) no decimals 8.2
	Out-of-range Signal	0	limit comparator OFF 8.2
SCL	SCale Low	0	Analog input 1 8.3.1
SCH	SCale High	150	Analog input 1 8.3.2
SCL2	SCale Low	0	Analog input 2 8.3.3
SCH2	SCale High	100	Analog input 2 8.3.4
SPL	SetPoint Low	150	limits low setpoint to 160 °F 8.3.5
SPH	SetPoint High	15	limits high setpoint to 205 °F 8.3.6
OFF1	Actual value correction	0	Analog input 1 8.3.7
OFF2	Actual value correction	0	Analog input 2 8.3.8
OFF2	Actual value correction	0	Analog input 3 8.3.9
Df1	Digital filter time constant	0	Analog input 1 8.3.10

Set parameters

See Hint section 2.3, 'How to adjust parameters'

The actual value display, (0)
shows the current parameter value.

The setpoint display, (AL)
shows the parameter item you are adjusting.

Increase **▲** or decrease **▼** the value,
accept it by waiting 2 seconds.

Once it flashes, proceed to the next parameter
(HYS1) by pressing **PGM** and releasing.

Adjust all of the parameters as shown below.

Parameter level values:

Value	Item	Description	* Sec
160	AL	Limit value for comparator	8.2
5	HYS1	Switching differential for limit comparator	8.2
10	Pb.1	SPE setpoint external	9.2
80	dt	Derivative time	9.2
350	rt	Integral action time	9.2
-5	HYS1	Burner-on 5 °F below setpoint	5.5.1
3	HYS2	Burner-off, 2-stage	5.2.3
5	HYS3	Burner-off 5 °F above setpoint	5.5.1
0	q	Response threshold	5.6
1	H	Heating curve slope	5.5.1
0	P	Parallel displacement	5.5

Set user level values

See Hint section 3.4, 'How to change a setpoint'.

You may enter the user level, directly from
the basic display.

Press **PGM** and release.
The actual value display, (180)
shows the current user level item value.

The setpoint display, (SP 1)
shows the user level item you are adjusting.

Increase **▲** or decrease **▼** the value, accept it by
waiting 2 seconds. Once it flashes,
press **PGM** and release.

Adjust SP1 as shown below.

User level values:

Value	Item	Description	* Sec
100	SP 1	Set point 1	5.5.1

Setup is complete!

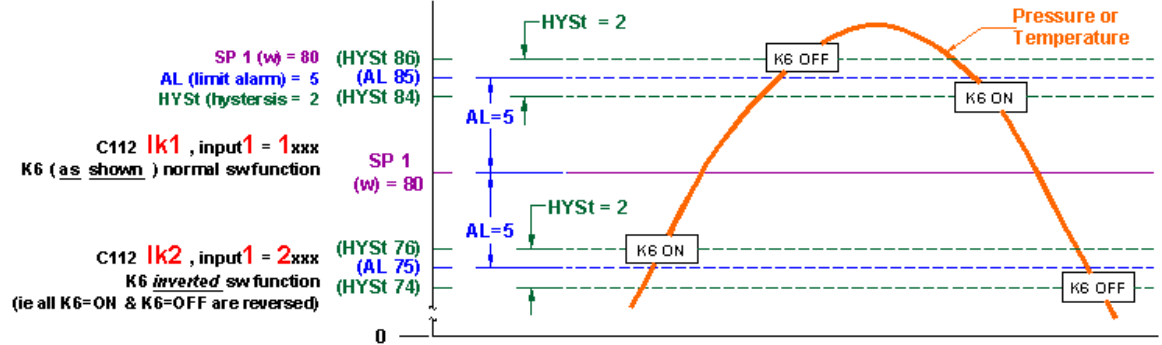
* Sec Refers to the RWF40 user manual section.



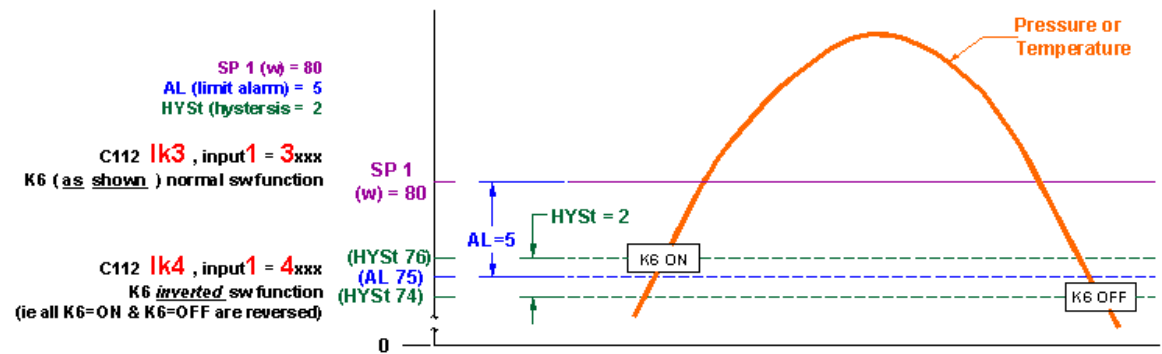
3. Notes

3.1 Logic summary K6 AL function Terminals Q64 & Q65.. , Ik1 thru Ik8

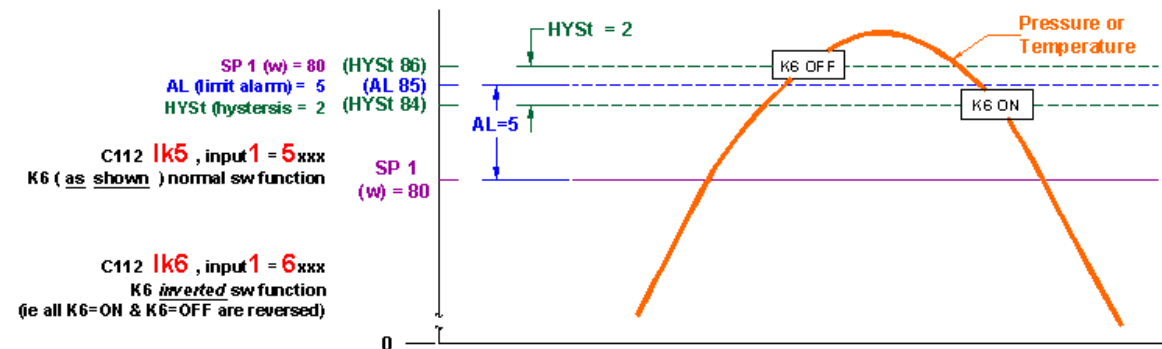
Window Function (setpoint)



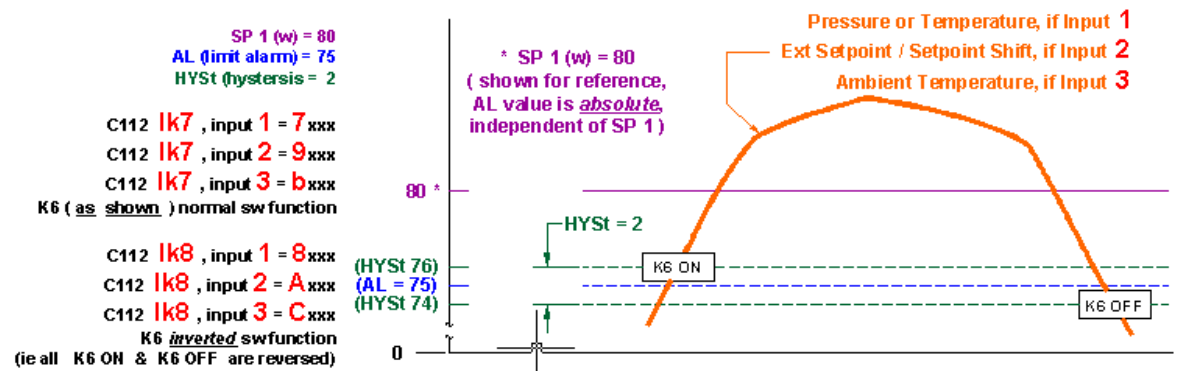
Lower Limit (setpoint)



Upper Limit (setpoint)



Absolute function (NOT related to setpoint)



3. Notes

3.2 Your record of values

RWF40 Man. Ref.	Setpoint Display	Your Setting	Configuration level items (Sec 6.4)	Range	Factory
Sec 8.1	C111		Analog input 1, 2 and 3; D2 setpoint changeover / shift	N / A	9030
Sec 8.1 / 8.2	C112		Limit comparator; controller type; setpoint 1; locking	N / A	0010
Sec 8.1	C113		Unit address; decimal place / unit, signal for out-of-range	N / A	0110

Sec 8.3.1	SCL		SCale Low, analog input 1, measured value range	-1999 to +9999	0
Sec 8.3.2	SCH		SCale High, analog input 1, measured value range	-1999 to +9999	100
Sec 8.3.3	SCL2		SCale Low, analog input 2, measured value range	-1999 to +9999	0
Sec 8.3.4	SCH2		SCale High, analog input 2, measured value range	-1999 to +9999	100

Sec 8.3.5	SPL		Set Point Low limit	-1999 to +9999	0
Sec 8.3.6	SPH		Set Point High limit	-1999 to +9999	100

Sec 8.3.7	OFF1		OFFset analog input 1, Actual value correction	-1999 to +9999	0
Sec 8.3.8	OFF2		OFFset analog input 2, Actual value correction	-1999 to +9999	0
Sec 8.3.9	OFF3		OFFset analog input 3, Actual value correction	-1999 to +9999	0

Sec 8.3.10	dF1		digital Filter, analog input 1, 2 nd order, in seconds	0 to 100	1
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Setpoint Display	Your Setting	Configuration level items, Modbus option (only RWF40.0X2B97) (Sec 6.4)	Range	Factory
Sec 8.3.11	dF3	Filter time constant, digital Filter, analog input 3 weather-dependent setpoint shift	0 to 1440	1278
Sec 8.3.12	oLLo	Working range, Limit Lower	1999 to +9999	-1999
Sec 8.3.13	oLHi	Working range, Limit High	1999 to +9999	9999
Sec 8.3.14	Dtt	Bus watchDog timer (in seconds)	0 to 7200	30

Setpoint Display	Your Setting	Parameter level items (Sec 6.3)	Range	Factory
Sec 7 / 8.2	AL	Alarm value for K6 Limit comparator (alarm programmable relay)	-1999 to +9999	0
Sec 7 / 8.2	HYSst	Hysteresis, (switching differential) for K6 limit comparator	0 to 999.9	1
Sec 7 / 8.2	Pb.1	Proportional band 1 (affects P-response of controller)	0.1 to 999.9	10
Sec 7 / 8.2	dt	derivative time (in seconds) (affects D-response of controller)	0 to 9999	80
Sec 7 / 8.2	rt	Integral action time (in seconds) , (affects I-response of controller)	0 to 9999	350
Sec 7 / 8.2	db *	dead band, contact spacing, * visible when C112 is xxx0, 3-pos modulating	0 to 999.9	1
Sec 7 / 8.2	tt *	Actuator running time (in seconds) , * visible when C112 is xxx0, 3-pos modulating	10 to 3000	15
Sec 7 / 5.1	HYS1	Switch-on threshold, HYSteresis 1, 2-stage burner	0 to -199.9	-5
Sec 7 / 5.2	HYS2	Switch-off threshold, HYSteresis 2, 2-stage burner	0 to HYS3	3
Sec 7 / 5.2	HYS3	Switch-off threshold, HYSteresis 3, upper	0 to 999.9	5
Sec 7 / 5.6	q	Response threshold (Q)	0 to 999.9	0
Sec 7 / 5.51	H	Heating curve slope	0 to 4	1
Sec 7 / 5.5	P	Parallel displacement (weather dependent setpoint shift)	-90 to +90	0

Setpoint Display	Your Setting	User level items (Sec 6.2.1)	Range	Factory
Sec 6.2.1	SP1	Set Point 1	SPL to SPH	0
Sec 6.2.1	SP2	Set Point 2, digital input 2, D2=0	SPL to SPH	0
Sec 6.2.1	dSP	digital Set Point shift, digital input 2, D2=1	SPL to SPH	0
Sec 11.1.3	tA	temperature, Ambient (outside) analog input 3, visible when C111 is xx1x, xx2x, xx3x		--
Sec 11.1.2	SP.E	Set Point External, predefinition, analog input 2, visible when C111 is xx1x, xx2x, xx3x	SPL to SPH	--

APPENDIX C

CB90 Flame Safety



CB90 FLAME SAFEGUARD CONTROLS for CLEARFIRE Boilers



WARNING: Selection of this control for a particular application should be made by a competent professional, licensed by a state or other government. Inappropriate application of this product could result in an unsafe condition hazardous to life and property.

DESCRIPTION

The CB90 Series Flame Safeguard Control is a compact, microprocessor based, modular burner management system designed to provide automatic ignition and continuous flame monitoring for commercial sizes of heating and process equipment firing any type of fuel. The advantages of the CB90 are zero dependence on discrete components previously used for timing functions.

A complete CB90 system consists of relay module 833-3162, programmer module 833-3163, amplifier module 833-3164, wiring subbase 833-3165 and a flame rod for flame detection. An optional alphanumeric display (833-2714) is available that provides complete English language description of the current operating status as well as diagnostic history.

The 833-3162 chassis contains a daughter board having provisions for local reset, remote display, modbus communications and normally closed relay contacts. The relay contacts are used to control the blower motor output speed. Terminal 5 of the chassis is used to release the burner to full modulation 5 seconds after the main burner establishing period.

Modular CB90 controls incorporate a safety checking circuit that is operative on each start. If flame (real or simulated) is detected prior to a start or during purge, the fuel valves will not be energized and unit will lock out.

Functions provided by the CB90 flame safeguard system:

1. 30 second high fire purge controlled by contacts on daughter board.
2. 10 second low fire purge controlled by contacts on daughter board.
3. Fixed 4 second flame establishing ignition period.
4. Ignition terminal off after flame establishing period.
5. 5 second flame stabilization period.
6. Pilot terminal 3 remains energized through the entire firing cycle.
7. 15 second Post Purge duration.
8. Release to modulate energized 5 seconds after AUTO.
9. Ignore state of air flow switch (interlock) for first 10 seconds of purge.
10. Retry three times if air flow opens during the pre-purge period.
11. Lockout on air flow during the run period.
12. Lockout on flame fail during the run period.
13. Modbus communications allowing for hookup to PLC system.
14. Smart LED's that provide on board diagnostic lockout information.
15. Amplifier test jacks provide uniform 0-10 vdc for flame signal strength.

SPECIFICATIONS

Supply: 120 VAC (min. 102, max. 132) 50/60 Hz.

Power Consumption: 12 VA (Operating)

Shipping Weight (Approx): 3 lbs (1.4 kg)

Operating Temperature: -40°F (-40°C) to 140°F (60°C)

Table 1: LOAD RATINGS: All Ratings are 120V, 60 Hz

Fireye Terminal	Typical Load	Maximum Rating @120V 60 Hz
3 or 4 Individual or combined	Pilot valve(s) Solenoid valve Ignition Transformer	125 VA pilot duty (solenoid valve) plus 250 VA (Transformer)
5	Release to modulation	125 VA pilot duty (solenoid) or 25 VA pilot duty (solenoid) and 400 VA (opening) motorized, 250 VA hold
8	Motor or Contactor	Terminal 8 rated to energize and de-energize 9.8 FLA, 58.8 LRA on safety lockout.
A	Alarm	125 VA, pilot duty
Minimum load requirement = 100mA		

Table 2: ALTERNATIVE LOAD RATINGS:

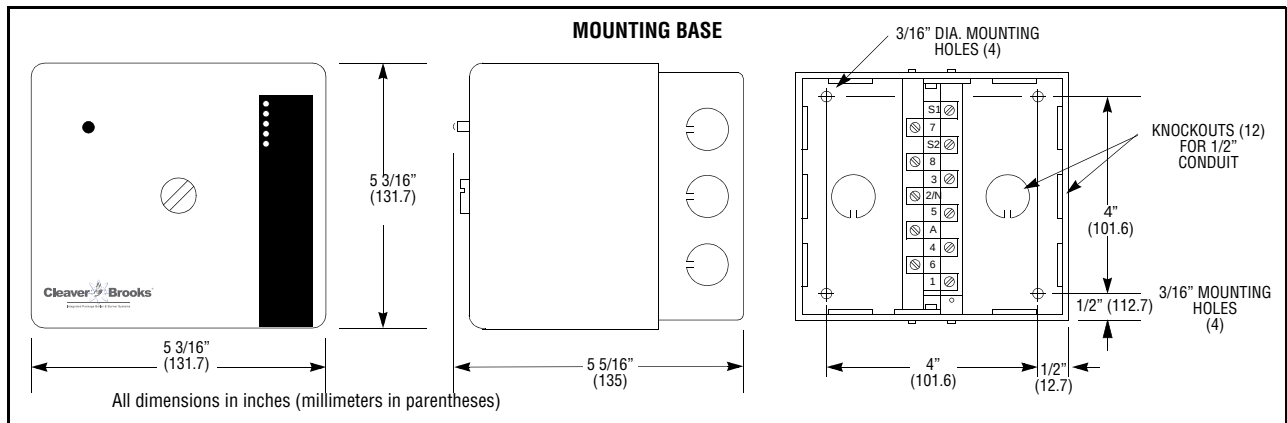
COMBINATION NUMBER	MAIN VALVE TERMINAL 3	IGNITION TERMINAL 4	RELEASE TO MODULATE TERMINAL 5
1	C	NO LOAD	E
2	B	NO LOAD	E
3	NO LOAD	NO LOAD	E
4	E	A	E
5	NO LOAD	A	E
6	D	A	E
7	D	A	D
8	NO LOAD	A	D

Table 3: COMPOSITION OF EACH COMBINATION

A	B	C	D	E
4.5A Ignition	50 VA Pilot Duty plus 4.5A ignition	180 VA Ignition plus motor valves with: 600VA in rush., 360 VA open, 250 VA hold	2A Pilot Duty	65 VA Pilot Duty plus Motor valves with: 3850 VA in rush., 700 VA open, 250 VA hold



CAUTION: Published load ratings assume that no control be required to handle inrush current more often than once in 15 seconds. The use of control switches, solenoids, relays, etc. which chatter will lead to premature failure. It is important to run through a test operation (with fuel shut off) following the tripping of a circuit breaker, a blown fuse, or any instance of chattering of any external current consuming devices.



WARNING: This equipment is a Class B digital apparatus which complies with the Radio Interference Regulations, CRC c.1374.

Table 5: AMBIENT TEMPERATURE LIMITS

	MAXIMUM		MINIMUM	
Control	140°F	60°C	- 40°F	- 40°C

APPROVALS

Underwriters Laboratories Inc.
Listed Guide MCCZ - File MP1537

Factory Mutual System (FM) Approved

Underwriters Laboratories Inc.
Recognized Components Guide MCCZ2
File MP1537



WARNING: Selection of programmer and amplifier type for a particular application should be made by a competent professional, such as a Boiler/Burner technician licensed by a state or government agency, engineering personnel of the burner, boiler or furnace manufacturer (OEM) or in the performance of duties based on the information from the OEM.



WARNING: This equipment generates and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user, at his own expense, will be equipped to take whatever measures that may be required to correct the problem.



In order for the CB90 to gather and retain statistical and historic data such as burner hours, burner cycles, system hours and average flame signal, it is necessary that Terminal 1 be powered at all times. Removing power from Terminal 1 at the end of the firing cycle causes all data gathered during the previous 16 hours or last 9 cycles to be lost.

ORDERING INFORMATION

CB90 Components	
833-3162	Chassis, 120 VAC input with normally closed relay output terminals, alpha-numeric display interface to 833-2714, and Modbus capability.
833-3163	Programmer, non-recycle on main flame fail, 30 second purge, 4 second fixed TFI, 5 second stabilization period, early spark termination. Non-recycle on air flow failure during run period. 15 second post purge. run/check switch.
833-3164	Amplifier, flame rod / photocell amplifier, 3 second FFRT.
833-3165	Open wiring base, cabinet mounting.

Accessories	
833-2714	Two line by 16 character, back lit LCD display with keypad.
833-2974 833-3491	Remote display cable with RJ45 connection in 2 or 4 foot long lengths. To be used with the appropriate daughter board.
833-3492	RS232/RS485 converter with power supply and RJ12 jack.
833-2715 833-3133	833-2714 remote display mounting kit with 4' or 2' cable respectively. Provides NEMA 4 protection.
833-3493	Monitoring device using cellular networks. Provides various reporting methods

For a complete system, choose one of each of the following:

- Chassis
- Flame Detector
- Programmer Module
- Wiring Base
- Amplifier Module



WARNING: Installer must be trained and qualified. Follow the burner manufacturers instructions, if supplied. Otherwise, proceed as follows:

INSTALLATION OF CONTROL, SCANNERS AND FLAME DETECTORS

Wiring Base

Mount the wiring base on the burner or on a panel. The location should be free from excessive vibration and within the specified ambient temperature rating. The base may be mounted in any angular position.

All wiring must comply with NEC Class 1 (Line Voltage) wiring and applicable electrical codes, regulations and local ordinances. Use moisture resistant wire suitable for at least 90 degrees C. Good electrical wiring practice should be followed to ensure an adequate ground system. Refer to General Grounding Rules later in this document for grounding methods.

A good ground system should be provided to minimize the effects of AC quality problems. A properly designed ground system meeting all the safety requirements will ensure that any AC voltage quality problems, such as spikes, surges and impulses have a low impedance path to ground. A low impedance path to ground is required to ensure that large currents involved with any surge voltages will follow the desired path in preference to alternative paths, where extensive damage may occur to equipment.



WARNING: Controls require safety limits utilizing isolated mechanical contacts. Electronic limit switches may cause erratic operation and should be avoided.



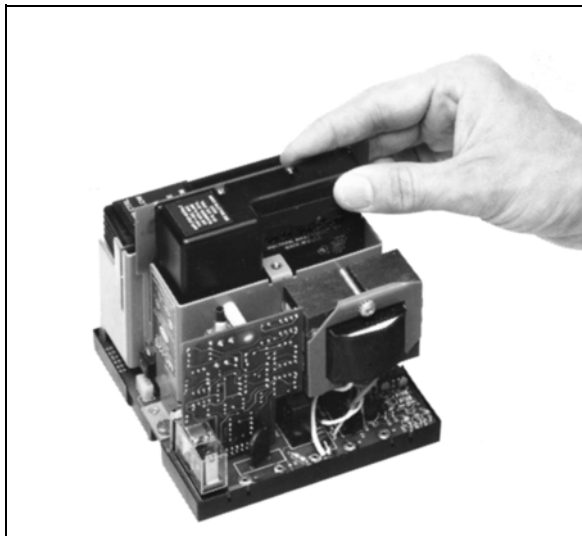
Care must be taken to NOT route the high energy ignition wire in close proximity to the flame sensor wiring, particularly when using 833-3164 amplifier.

INSTALLING THE PROGRAMMER AND AMPLIFIER MODULES

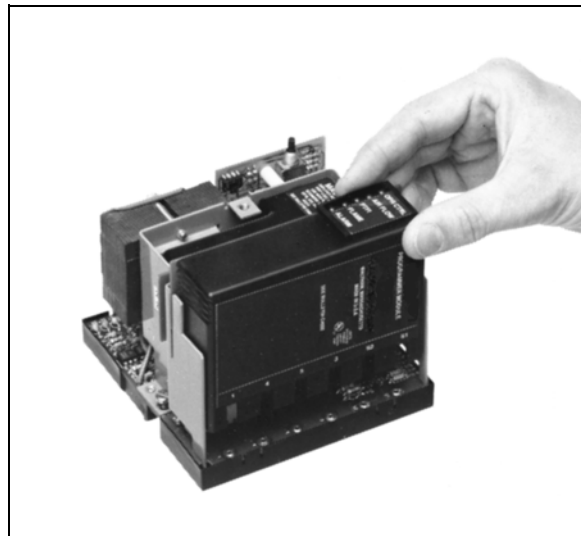


WARNING: Remove power from the control before proceeding.

FIGURE 1.



AMPLIFIER



PROGRAMMER

Remove the dust cover from the chassis. Insert the amplifier module into the slot in the corner of the chassis and gently push the module into position. Insert the programmer module into the slot at the right side of the chassis and gently push the module into position.



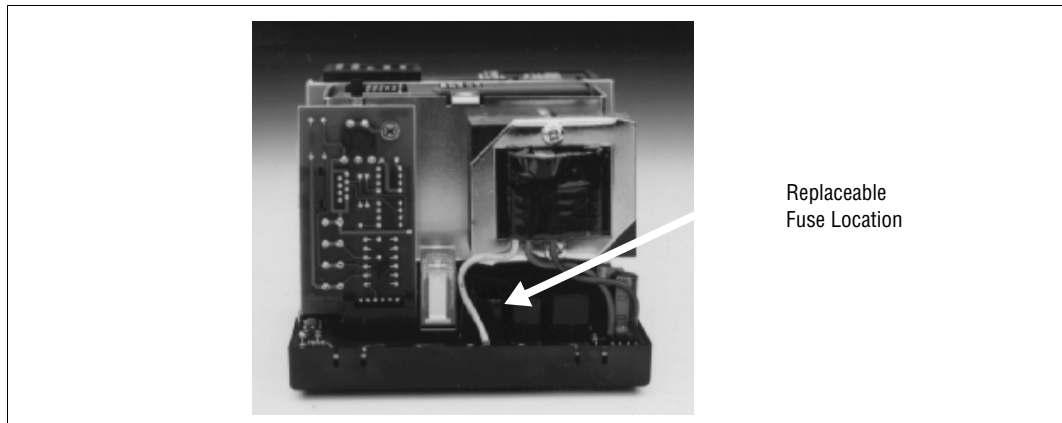
WARNING: Turn off the power when installing or removing the control.

Replaceable Fuse

The chassis modules are designed with a field replaceable fuse. The fuse is located on the printed circuit board below the transformer. In the event the fuse becomes OPEN, the Operating Control, TFI, and Flame LED's will light. However, relays KL or KF will not be energized and the control will lock out and indicate Lockout, Check Blown Fuse. The fuse will blow as a result of an overload condition on Terminals 3, 4, or 5. To replace the fuse, remove power from the system and using a small screwdriver or similar tool, install a replacement fuse (P/N 833-2398) or equivalent 10 amp fuse (e.g. Wickman # 19373-071-K).



WARNING: Disconnect power before servicing.

FIGURE 2.

LED INDICATOR LIGHTS

The CB90 Programmer Module has 5 LED lights to indicate the operating status of the control and also to display the coded sequence under locked out conditions. The function of the lights under a normal operating condition is:

Operating Control: This LED is energized whenever the burner control switch and all other various limit switches are closed and power is applied to Terminal #7.

Interlock or Air Flow: This LED is illuminated whenever power is detected on Terminal #6, indicating the air flow switch or other running interlock is closed. If the operating control is closed and the running interlock switch remains open, this LED will flash at a 1 second rate.

TFI: This LED is illuminated only during the pilot trial for ignition period and the stabilization period when so equipped.

Flame: This LED is on whenever a flame signal is detected, and the control is not in a locked out state.

Alarm: This LED flashes when an alarm condition is detected and is used as an address indicator (see communication).

During an alarm condition, the Alarm LED is made to flash at approximately a 1 second rate. The remaining four LEDs are illuminated as a coded sequence identifying the reason for the lockout.

While in the Idle or Off state, the LEDs are made to flash sequentially to show the operational status of the control every minute. The LEDs can be tested by pressing and releasing the Reset push button, while in the Idle or Off state.

LOCKOUT CODES

MSGN		DESCRIPTION	OP CTRL	AIRFLOW INTLCK	TFI	FLAME	ALARM
DEC	HEX						
6	6	Lockout Line Frequency Noise Detected	●	○	○	●	*
7	7	Lockout Flame Fail - TFI	○	●	●	●	*
15	0F	Lockout Fault Unknown	●	●	●	●	*
16	10	Lockout Amplifier High Count Fail	○	○	○	○	*
19	13	Lockout Flame Fail - MTFI	○	○	●	●	*
20	14	Lockout False Flame - STANDBY	○	●	○	○	*
21	15	Lockout Intrlck Open	●	●	●	○	*
22	16	Lockout Intrlck Closed	○	●	●	○	*
24	18	Lockout Chassis Opto	●	●	○	●	*
37	25	Lockout Flame Fail - AUTO	○	●	○	●	*
39	27	Lockout Fuel Valve State Change	○	○	○	●	*
54	36	Lockout Check Chassis	○	○	○	●	*
55	37	Lockout Check Programmer	○	○	●	○	*
56	38	Lockout Check Amplifier	●	○	○	○	*
58	3A	Lockout Amplifier Auto Check Fail	●	○	●	○	*
59	3B	Lockout Check BLOWN FUSE	●	○	●	●	*
76	4C	Lockout Check Scanner	●	●	○	○	*
N/A	N/A	System Error	*	*	*	*	●

○ = NOT LIGHTED

● = LIGHTED

* = FLASHING

All LED's Flashing indicates defective programmer.

The CB90 chassis is shipped with a convenient peel off label that can be applied to any surface (inside cover) for future reference.

DIAGNOSTIC MESSAGES - TROUBLESHOOTING GUIDE

	POSSIBLE CAUSE	SOLUTION
Check Programmer	Voltage on Terminal 5 at improper time.	Inspect wiring to main fuel valve
	Welded watchdog relay	Replace chassis
	Internal diagnostic failure	Replace programmer
Check Chassis	Voltage on Terminal 3 or 4 at improper time.	Inspect wiring to pilot valve and igniter.
	Welded watchdog relay	Replace chassis
Chassis Opto	Opto-Coupler(s) short circuited	Replace chassis
Amplifier High Count Fail	Amplifier signal level high	Replace Amplifier module
Amplifier Auto Check Fail	Flame signal too high	Use orifice in sight pipe
	Internal Amplifier diagnostic fault	Replace Amplifier module
Check Scanner	Defective shutter	Inspect scanner wiring, replace scanner
	UV tube false firing	Replace UV tube or scanner
Check Blown Fuse	No power detected on terminal 3	Inspect defective pilot valve or igniter
	Defective fuse	Replace fuse
Line Frequency Noise Detected	Spikes detected on AC mains	Check for SCR motors or DC drives
		Inspect ground system
Fuel Value State Change	Terminal 5 (main fuel) detected on during TFI	Check external wiring or replace chassis
Check Amplifier	Amplifier not passing diagnostic tests	Replace Amplifier module
System Error	Noise transient	Check high energy ignition noise location. Be sure it is not arcing to chassis or wrapped with scanner wiring.

833-3163 PROGRAMMER SEQUENCE

The 833-3163 programmer provides additional logic used to control the modulation relay separately. This allows the control of the blower speed allowing for a complete purge and release to modulation control during AUTO.

FUNCTION	TERMINAL	STANDBY	PURGE 30 SEC.	LOW PURGE 10 SEC.	TFI 4 SEC.	STABILIZATION	AUTO	POST PURGE 15 SEC	CYCLE COMPLETE
OPERATING CONTROL	7								
BLOWER	8								
AIR FLOW INTERLOCK	6		10 Sec	← AIRFLOW MUST CLOSE 10 SECONDS AFTER CYCLE START					
IGNITION	4					← SPARK CUT-OFF			
MAIN VALVE	3								
MODULATE	5								
LOW FIRE	AUX Relay	Energize	De-energize	Open	10 SEC TO BRING BLOWER TO LOW SPEED		STATE CHANGE 5 SECONDS AFTER AUTO		
FLAME SIGNAL	S1-S2	Closed			Closed			Closed	

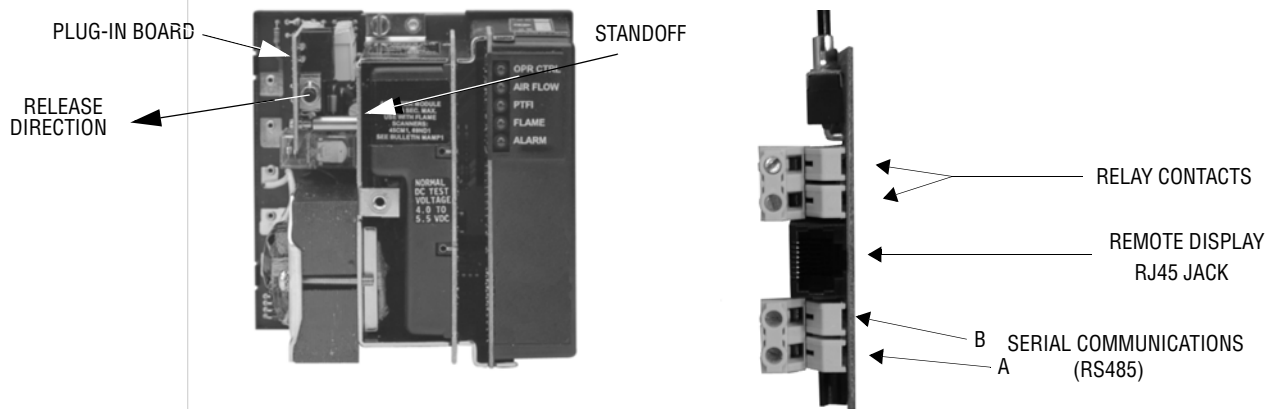
1. Recycle 3 times on air flow failure during purge.
2. Non-recycle on flame fail.
3. Non-recycle on air flow flame failure while flame on.

PLUG-IN DAUGHTER BOARDS

Description

A plug-in board is pre-installed in the 833-3162 chassis to provide local reset, remote alpha-numeric display, serial communications and normally closed relay contacts.

FIGURE 3. PLUG-IN BOARD LOCATION AND INSTALLATION



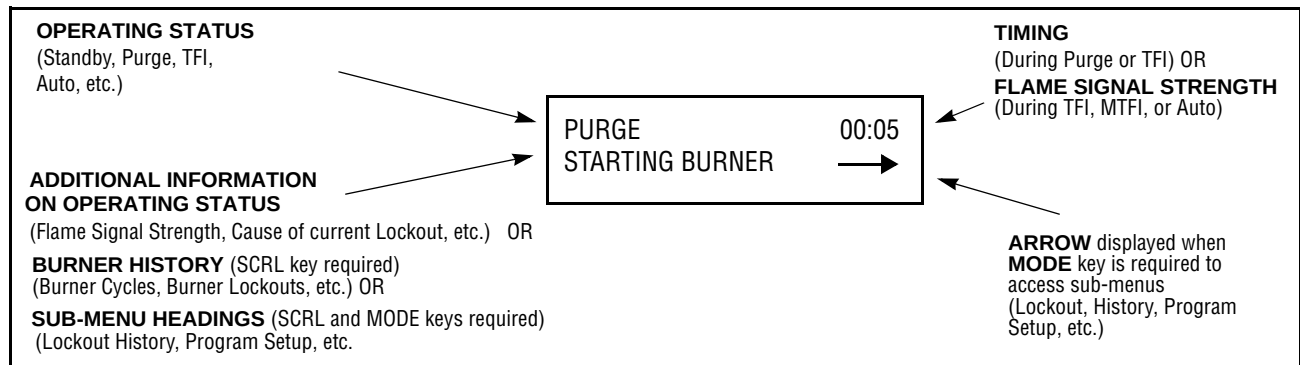
REMOTE DISPLAY

The CB90 provides an interface to the optional 833-2714 display module. The 833-2714 connects to the CB90 through the plug-in board using a 833-294 (2 f.t) or 833-3491 (4 ft.) cable. Part numbers 833-2715 (4 ft.) and 833-3133 (2 ft.) are available for remote mounting to the 833-2714 Display Module and to provide NEMA 4 protection.

The 833-2714 Display Module is a backlit, 2 line by 16 character LCD display with keypad to provide both current operation and historical information of the CB90. The 833-2714 contains a keypad consisting of three push keys, SCRL, RESET and MODE. Remote reset is available through the 833-2714 Keypad.

The 833-2714 displays current burner status, first out annunciation in the event of a lockout condition, historical burner information, detailed lockout information of the last six (6) lockout conditions and programmer configuration information. Through the display the ability to program the unit address for communications, as well as resetting the stored information (cycles, hours, and lockouts) to zero is provided.

Depending on the information being displayed, data is displayed on the 833-2714 screen in the following locations:



At any time the CB90 is powered, the SCRL key is used to scroll through and display the total number burner hours, burner cycles, burner lockouts and system hours on the bottom line of the 833-2714 display. The top line will continue to show the current run mode of the control (e.g. PURGE, AUTO, etc.) Following the historical information, the SCRL key will display three (3) sub-menus providing the following information and/or functions:

- Lockout History (with burner cycle and burner hour time stamp).
- Program Setup (to display programmer type, purge timing, switch configuration, etc.)
- System Information (values of average pilot and main flame signal, and reset burner history).

The system sub-menus require the MODE key to gain access to the information associated with each sub-menu. An arrow is displayed in the lower right hand corner of the display to indicate a system sub-menu is available. Once within the sub-menu, pressing the SCRL key displays the next item within the sub-menu, and pressing the MODE key will exit the sub-menu and return the display to the top of the main menu.

AUTO	40
BNR HOURS	673

Number of burner operating hours. (Terminal #5 energized).

AUTO	40
BNR CYCLES	2784

Number of burner cycles.

AUTO	40
BNR LOCKOUTS	21

Number of burner lockouts.

AUTO	40
SYS HOURS	1386

Number of hours the control has been powered.

AUTO	40
LOCKOUT HISTORY	→

Sub-menu to display the cause of the last 6 lockouts. The MODE key is required to display the actual lockouts.

AUTO	40
PROGRAM SETUP	→

Sub-menu to display various operating parameters of the programmer and amplifier. The MODE key is required to enter the sub-menu.

AUTO	40
SYSTEM INFO	→

Sub-menu to display information pertaining to the operation of the control. The MODE key is required to enter the sub-menu.

LOCKOUT HISTORY

The sub-menu “LOCKOUT HISTORY” will display the last six (6) lockouts, along with the burner cycle and burner hour when the lockout occurred. When the MODE key is pressed, the screen will display the most recent lockout condition and the number of that lockout (e.g. LO #127 represents the 127th lockout of that control). The SCRL key will display the Burner Hour, followed by the Burner Cycle when the lockout occurred. The SCRL key will advance to the next lockout, and repeat the sequence listed above. The MODE key will exit the sub-menu.

PRESS	SCREEN DISPLAYS	DESCRIPTION
SCRL	AUTO 45 LOCKOUT HISTORY	Scrolling through the historical information.
MODE	LO #127 TFI FLAME FAIL	The latest (most recent) lockout condition. This is the 127th lockout of the control. History indicates the lockout occurred during TFI.
SCRL	LO #127 TFI @ BNR HOURS 136	The last lockout occurred after 136 hours of burner operation.
SCRL	LO #127 TFI @ BNR CYCLE 744	The last lockout occurred at burner cycle 744.
SCRL	LO #126 PURGE AIR FLOW OPEN	The second latest lockout condition. This is the 126th lockout of the control. History indicates the lockout occurred during purge.
MODE	AUTO 45 FLAME SIGNAL	Screen has returned to the normal run message.

PROGRAM SETUP

The sub-menu “PROGRAM SETUP” allows the user to review the various operational settings of the programmer module (e.g. programmer type, purge timing, etc.). The MODE key is used to enter the “PROGRAM SETUP” sub-menu, and the SCRL key is used to advance through the sub-menu.

MODE	AUTO 45 PROGRAMR MEP345	Programmer Type is a MEP345.
SCRL	AUTO 45 ENGR CODE NO. 9	Software Engineering code of the programmer module is code 9.
SCRL	AUTO 45 AMP. TYPE = MERT	Amplifier module identified.
SCRL	AUTO 45 FLAME FAIL TIME = 3s	Flame Failure Response Time (FFRT) is 3 seconds.
SCRL	AUTO 45 PURGE TIME = 30s	Purge timing (selected by the dipswitches) is 30 seconds.
SCRL	AUTO 45 PTFI TIME = 4s	Prove 7-6 open to start is disabled (selected by dipswitches). Trial for ignition time is 4 seconds
SCRL	AUTO 45 POST PURGE = 0s	Post purge time is 0 seconds (selected by dipswitches).
SCRL	AUTO 45 TYPE NON-RECYCLE	Control recycles on flame fail.
SCRL	AUTO UNIT ADDRESS 00	Unit Address is 00. Refer to section on communications.
MODE	AUTO 45	Mode key returns to normal run message.

SYSTEM INFO

The sub-menu “SYSTEM INFO” allows the user to review information pertaining to the operation of the control (e.g. average main flame signal strength, status of the high fire and low fire end switches, etc.). The MODE key is used to enter the “SYSTEM INFO” sub-menu, and the SCRL key is used to advance.

Press	Screen Displays	Description
SCRL	AUTO 45 SYSTEM INFO >	SCRL key advances through the historical information until “System Info” is displayed. Pressing and releasing the MODE Key enters the sub-menu.
MODE	AUTO 45 AVG. PILOT FLM 22	The average flame signal strength of the pilot flame = 22
SCRL	AUTO 45 AVG. MAIN FLM 40	The average flame signal strength of the main flame = 40.

SCRL	PRESS RESET TO CLEAR HISTORY	Historical data will be cleared to 0. Must be done while terminal I-7 is open.
MODE	AUTO 45 FLAME SIGNAL	Mode key returns to run message.

COMMUNICATIONS

The protocol to be used is Modbus RTU. This is implemented by the master (PC, PLC, etc.) issuing a poll to the slave (CB90) and the slave responding with the appropriate message.

A typical format of a poll request is as follows:

DST	FNC	ADR HI	ADR LO	DAT HI	DAT LO	CRC LO	CRC HI
-----	-----	-----------	-----------	-----------	-----------	-----------	-----------

DST refers to the logical address of the slave set but using reset pushbutton or 833-2714.

FNC is the function being requested. FNC 03 is a read request.

ADR is the message number or register number of the data being requested. In Modbus, register addresses begin at 40001 but is interpreted as address 00.

DAT is the number of words being requested. A word is an integer consisting of 2 bytes.

The normal response from a slave is as follows:

DST	FNC	DBC	DATA.... Hi/Lo	CRC LO	CRC HI
-----	-----	-----	-------------------	-----------	-----------

DBC is the data byte count being returned. It must be two times the DAT number from the poll request.

DATA is the data returned and is always a series of 2 byte integers. If 4 words were requested then DBC would be 8 and there would be 8 data bytes or 4 data words containing the requested data.

The format of the data is 4800,N,8,1 meaning 4800 baud, no parity, and 1 stop bit.

Below is a table of currently available messages provided by the CB90 programmers, followed by a description where necessary.

MESSAGE ADDRESS	WORDS REQUESTED	RESPONSE	VALUE
00	1-6	STATUS	83 (053H) = RUN; 202 (0CAH) = LOCKOUT
01	1	MSGN	Current message being displayed (see Table 2)
02	1	GSTAT	Defines Timer Type
03	1	TIMER	Time, Flame, Address
04	1	FLAME	Flame Signal
05	1-3	LOGSTAT	Current logic module, PURGE, TFI, AUTO (see Table 1)
06	1	INPUTS	Input limits state
07	1	OUTPUTS	Output relays state
08	2, 4 or 8	SYSMINS	System on minutes
10	2 or 4	BNRMINS	Burner on minutes
12	2	CYCLES	Completed Burner Cycles
14	1	LOCKOUT COUNT	Stored Lockout Count
15	1-6	LOCKOUT HISTORY	Last 6 Lockouts, first word is the most current lockout
21	1-2	DEVTYPE	Programmer device type, 7=CB90
22	1	AMPTYP	Amplifier Type; 833-3164=0B0H
23	1	PROGTYP	Programmer Type (N/A)
24	2	FLAME SIGNAL AVERAGES	TFI and Auto Flame Signal Averages
26	1-9	Combined Status	See Description Below
35	6	Most Recent Lockout Data	Returns complete lockout description of stored lockout history. Includes lockout message, lockout module, @ burner hours, and @ burner cycles
41	6	2nd Most Recent Lockout Data	
47	6	3rd Most Recent Lockout Data	
53	6	4th Most Recent Lockout Data	
59	6	5th Most Recent Lockout Data	
65	6	6th Most Recent Lockout Data	

Messages 00, 05, 08, 10, 15, 21 and 26 are unique in that a limited number of successive registers can be combined with these requests. For example, a request to message 00 can contain up to 6 data words. The response to this would contain STATUS, MSGN, GSTAT, TIMER, FLAME and LOGSTAT. If the requested data word count (DAT) were to be 2 then the response would contain STATUS and MSGN only. Message 15, last 6 lockouts, can return data ranging from 1 to 6, with 1 referring to the most recent lockout.

Message 26 returns the current operating status as well as stored burner hours and burner cycles as a snapshot of the entire CB90 system. When all 9 words are requested, the data returned consists of STATUS, MSGN, FLAME, INPUTS, OUTPUTS, BNRMIN, and BNRCYC.

The MSGN being transmitted is a numerical value and must be interpreted by the communicating device, which actually is an advantage since this can be made to be whatever message text the end user wants. In other words, it allows for programming custom messages without actually changing the message in the programmer.

The CB90 stores its burner on time (Terminal 5 powered) and system on time (L1 powered) in minutes. Internally, the programmer converts this to hours for display purposes, however the result is

rounded down. The information being supplied by Modbus will be the actual time in minutes and it is up to the communicating device to do the conversion. Since the maximum value stored in the CB90 is 9,999,999 minutes, the maximum value in hex therefore, is 98967FH and comprises of two data words. The maximum cycle count is 999,999 decimal or 0F423FH, still two data words. As an example, the System on Minutes data is transmitted from the CB90 to the interface as high word / low word as shown below:

MESSAGE ADDRESS 8		MESSAGE ADDRESS 9	
HIGH WORD		LOW WORD	
HIGH BYTE	LOW BYTE	HIGH BYTE	LOW BYTE
0	98H	96H	7FH

Note: Data from address 9 cannot be accessed directly.

All values are represented in a HEX or base 16 format.

GSTAT determines the type of value TIMER represents. TIMER can be a running timer such as is used in purge, a flame signal or meaningless. Only the lower nibble of GSTAT has any value. If this value is 0 then the TIMER value has no meaning. The value in TIMER is a background minute timer in the CB90 and should be ignored. If GSTAT is between 4 and 7, the TIMER represents the current value flame signal. If GSTAT is a 1, 2, or 3 then TIMER represents a running timer value.

The baud rate of the CB90 is fixed at 4800 bits per second. The format of the data is 8 data bits, no parity and 1 stop bit. Due to the RS485 format, the communication format is considered half-duplex. That is, only one user is permitted on the communication lines at a time.

The information contained in INPUTS and OUTPUTS represents the status of the interlocks and relays respectively. For the INPUTS, a 1 in the interlock position defines the interlock as being on or energize where the 1 in any bit position in the OUTPUT register signifies the relay as being energized.

			Term 5	Term 3	Term 6	Term 7	
Reset	Scrl	Mode	RF	Main Fuel	Intrlck	OpCntrl	Ref

Reset, Scrl and Mode represent the keypad located on the 833-2714 display. A '0' in any of these positions indicates the switch is depressed. A '1' in the opto-coupler position indicates the opto-coupler is on or interlock closed.

			Term 8	Term A	Term 3	Term 5	Term 4
N/A	N/A	N/A	Blower	Alarm	Main Fuel	Modulation	MTFI

A '1' in any terminal position indicates the relay is energized. Term 4 indicates the state of K1 relay, located in the MEP500 series programmers.

It is suggested that repeated polling interval not be less than 200 mSec per request. Requesting data such as burner minutes, system minutes and burner cycles be kept at a minimum due to the amount of processing time required to gather that data.

Table 1

LOGIC DISPATCHER		
VALUE		CB90
HEX	DEC	
45H	69	MPOSTIDLE
46H	70	MPREPURGE1
47H	71	MPURGE
48H	72	MTFI
49H	73	MSTABLE
4AH	74	MTFMF
4BH	75	MAUTO
4CH	76	MSHTDWN1
4DH	77	MSHTDWN2
4EH	78	MIDLE

Logstat represents the current software module the CB90 is currently executing. They are named as close to the logic module the actual burner sequence is in. For instance, in the CB90, MPURGE represents High Fire Purge where MPOSTPURGE represents low fire start purge. MSHUTDWN1 represents the post purge period after a complete cycle or the cool down period after a lockout.

MIDLE or STANDBY is the period of time where the operating control is open or the control is in lockout waiting for reset. On instances of false flame during the purge period, the control algorithm forces the control back to STANDBY until false flame ceases or lockout occurs.

MPREPURGE1 is the period of time prior to PURGE where the control checks the status of the air flow interlocks or in the case of the Flame-Monitor, high fire proving switch (D-8). If found open, the control will remain in this state until the respective switch closes or lockout occurs.

MTFI represents the pilot ignition stage of a burner sequence. MTFMF represents the main trial for ignition period where main fuel is introduced along with pilot.

MAUTO is the run period of the burner sequence.

MPOSTIDLE and MSHTDWN2 are small periods of time where certain internal tests are conducted and general cleanup before and after a cycle is performed.

PROGTYP is represented by 1 data word. The upper byte identifies the family and the lower byte represents the programmer type within the family. The data represented by PROGTYP can be used to guard against the wrong programmer being installed in a system.

Table 2: MESSAGE DESCRIPTION

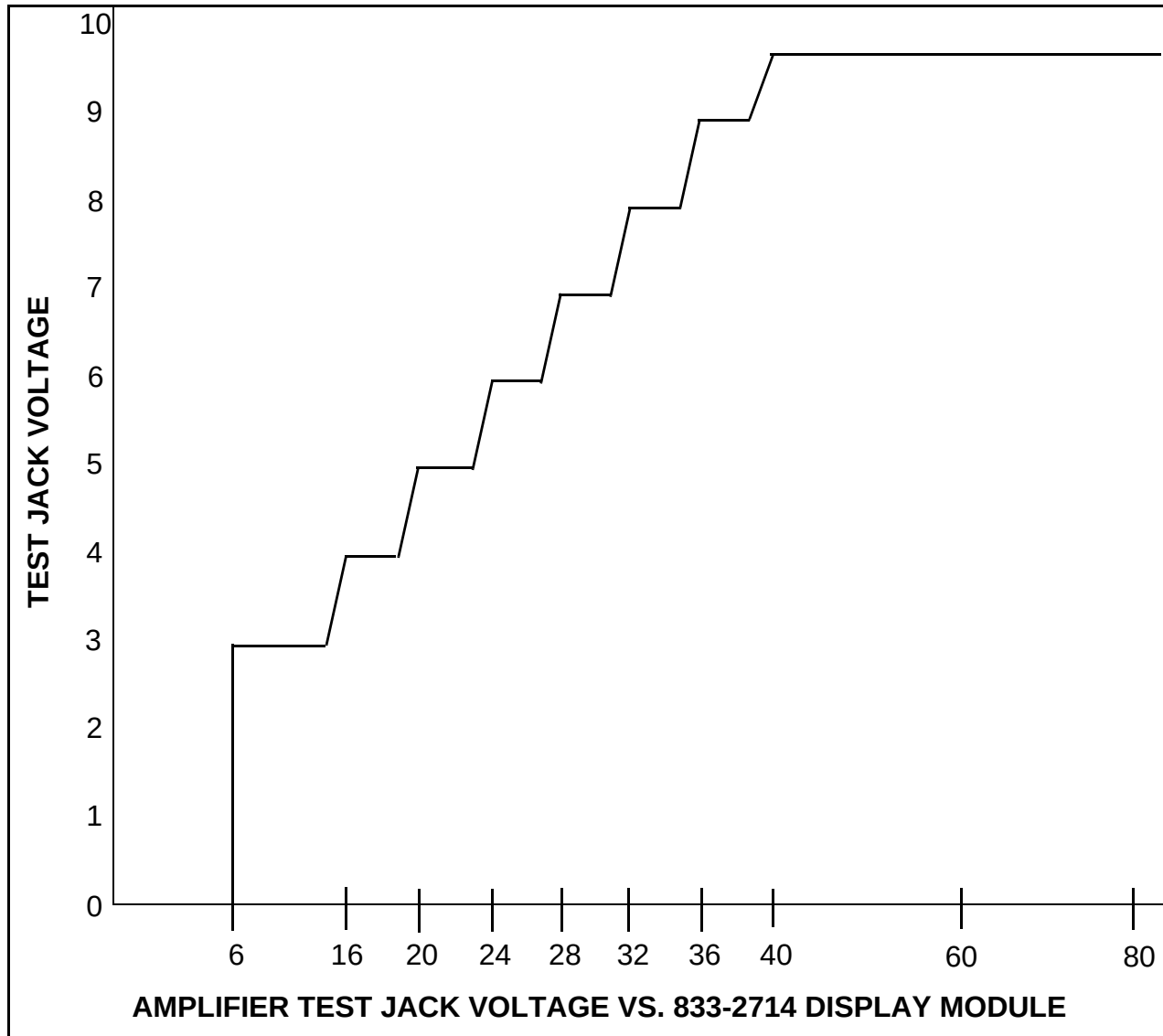
DEC	HEX	CB90 Message
1	1	L1-7 OPEN
2	2	FALSE FLAME
3	3	STARTING BURNER
4	4	
5	5	INTRLCK OPEN
6	6	LOCKOUT LINE FREQUENCY NOISE DETECTED
7	7	LOCKOUT FLAME FAIL - TFI
8	8	UNIT ADDRESS
9	9	MTFI
10	0AH	IGNITION TIMING
11	0BH	
12	0CH	FLAME SIGNAL
13	0DH	CYCLE COMPLETE
14	0EH	OFF
16	10H	LOCKOUT AMPLIFIER HIGH COUNT FAIL
19	13H	LOCKOUT FLAME FAIL – MTFI
20	14H	LOCKOUT FALSE FLAME – STANDBY
21	15H	LOCKOUT INTRLCK OPEN
22	16H	LOCKOUT INTRLCK CLOSED
23	17H	INTRLCK CLOSED (PROVING AIR FLOW OPEN AT START)
24	18H	LOCKOUT OPTO FAILURE
30	1EH	FALSE FLAME
37	25H	LOCKOUT FLAME FAIL - AUTO
39	27H	FUEL VALVE STATE CHANGE
40	28H	AIR FLOW CLOSED
49	31H	LOCKOUT FLAME FAIL - TFI
54	36H	LOCKOUT CHECK CHASSIS
55	37H	LOCKOUT CHECK PROGRAMMER
56	38H	LOCKOUT CHECK AMPLIFIER
58	3AH	LOCKOUT AMPLIFIER AUTO CHECK FAIL
59	3BH	LOCKOUT CHECK BLOWN FUSE
76	4CH	LOCKOUT CHECK SCANNER

Addressing Modes

For communication in a multi-burner or multi-control environment, each CB90 must have a unique address. The range of address allowed within the CB90 is 0 to 31 allowing for a possible 32 units to be connected in a single multi-drop node. As shipped the default address is 0. The address of the CB90 may be set using two methods. Using the 833-2714 display, it is necessary to SCRL to the PROGRAM SETUP menu and enter that submenu with the MODE key. SCRL down until the display indicates UNIT ADDRESS with the actual address of the CB90 being displayed on the top line of the display. Pressing and releasing the RESET key will cause the address to increment. The address after 31 is 0. The second method is to use the local reset located on the plug-in board. It is first necessary to open the operating control (L1-7) to have the CB90 in the IDLE or STANDBY position. Depressing the reset switch for greater than 10 seconds will cause the address of the CB90 to be displayed in a binary format on the LEDs located on the programmer board. Because the default is address 0, and since address 0 would mean no LEDs would be lit; the ALARM LED is made to flash when the address is 0. The OP CTRL LED is the least significant bit while the ALARM relay is the most significant bit. To increment the address counter, depress and release the RESET push button and observe the LED pattern. If the RESET switch is untouched for 30 seconds the current address displayed will be stored to memory and the CB90 will automatically exit the address mode.

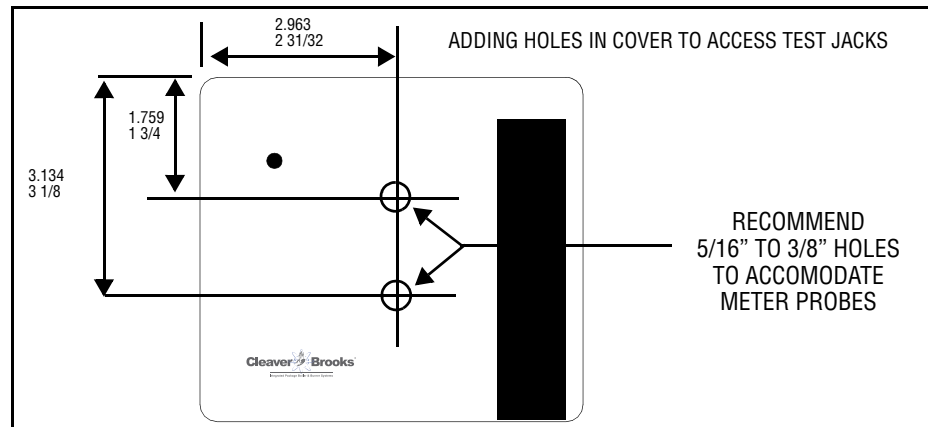
TEST JACK VOLTAGE

For all amplifiers, the CB90 provides a uniform 0-10 volt signal to represent the flame signal strength. A signal reading greater than 4 volts is considered sufficient to provide reliable operation. This same signal is also available in a numerical format on the 833-2714 display. The chart below correlates the test jack voltage to the numerical value. The signal clamps at 10 volts at a numerical value greater than 42 and the numerical value clamps at 80.



EXTERNAL METER CONNECTIONS

The test jacks are located on the amplifier card. If external access is desired for a panel meter the figure shown below will assist you in locating the position to drill through on the front cover. The hole sizes should be large enough to accommodate the body of the meter probes. The tests accept meter probes up to .080" or 2mm diameter.



INSTALLATION TESTING

Use of Test Meter (All Controls)

Testing the Cleaver Brooks CB90 Controls requires the use of a test AC/DC multimeter, with a minimum 1000 ohm/volt AC scale and 20,000 ohm/volt DC scale.

With the test meter on the DC scale, and the test meter leads inserted into the test jacks on the amplifier (Red for positive (+) polarity, Black for minus (-) polarity), a DC voltage reading of 4.0 to 10 volts for all amplifier types should be obtained when the control is detecting flame and 0 volts when no flame is present. Wildly fluctuating readings are an indication of an unstable flame or flame sensor requiring maintenance. Inadequate flame signal may be improved by:

1. Assuring that the flame detector and wiring installations have followed the instructions beginning on page 25.
2. Assuring that the flame detector is clean and within the ambient temperature limits.
3. Assuring that the flame is sufficiently large to detect.
4. Assuring that the flame quality (fuel to air ratio, combustion air velocity) is satisfactory.
5. Trying a shorter sight pipe or increasing the sight pipe diameter. **(The burner manufacturer should be consulted before mechanical changes are made).**

When using a flame rectification amplifier, a micro-ammeter may be connected in series with the wire to Terminal S2. Normal flame will produce a meter reading between 4 and 10 micro-amps.

With the test meter on the AC scale, line and load voltages may be measured at the identified test points on the chassis.



WARNING: Before making a pilot flame test, manually shut off the fuel supply to the main burner.

Normal Pilot Flame Test (Programmers with Run/Check Switch)

1. At pilot trial for ignition (TFI) place the Run/Check switch in the Check position.
2. During the pilot flame test and adjustment period, if flame is not detected within 30 seconds, the control will lock out and require manual reset to initiate another cycle.

3. Observe the pilot flame signal on the test meter or the 833-2714 display. If the flame signal is below 4.0 volts DC or a reading of 10 on a remote display, re-adjust the pilot flame or realign the flame detector.



WARNING: DO NOT TOUCH a flame rectification rod with power applied.

4. When using UV detection, a test is required to verify that UV radiation from the ignition spark is not being detected. To accomplish this, manually shut off both the pilot and main fuels. Initiate a normal start-up. Observe the test meter which should read no more than 1/2 volt DC. If higher levels are observed, realign the UV scanner, and/or shield the spark from the scanner's view.
5. Move the Run/Check switch to the Run position, check pilot flame response time by manually shutting off the pilot fuel and initiate a normal start-up. With no pilot flame present, the control will de-energize the pilot assembly at the end of the trial for ignition interval (selectable by dipswitch #4) and go into safety shutdown.



WARNING: The minimum pilot test must be accomplished by a trained and qualified burner technician.

Minimum Pilot Test

This test assures that the flame detector will not sense a pilot flame too small to light a the main flame reliably. It must be made on every new installation as well as following the repositioning or replacement of the flame detector. This procedure should not be used on a direct spark burner.

1. Manually shut off the fuel to the main burner.
2. Place the Run/Check switch in the Check position (if supplied).
3. Connect a test meter to the test jacks on the Amplifier Module or observe the reading on the 833-2714 display.
4. Initiate a normal start-up.
5. Reduce the fuel to the pilot until the DC voltmeter reads 4.0 volts. This is the minimum pilot. For flame rectification the flame signal for minimum pilot varies depending on the application. See WARNING below.
6. Return the Run/Check switch to the Run position (if supplied).
7. Slowly turn on the main fuel and insure the main flame lights off promptly and normally.



WARNING: If light off is delayed, shut off the power to the installation. Realign the flame detector so a larger pilot flame is required before flame is detected. Repeat this test until the main flame lights reliably with minimum pilot.

Flame Failure Test

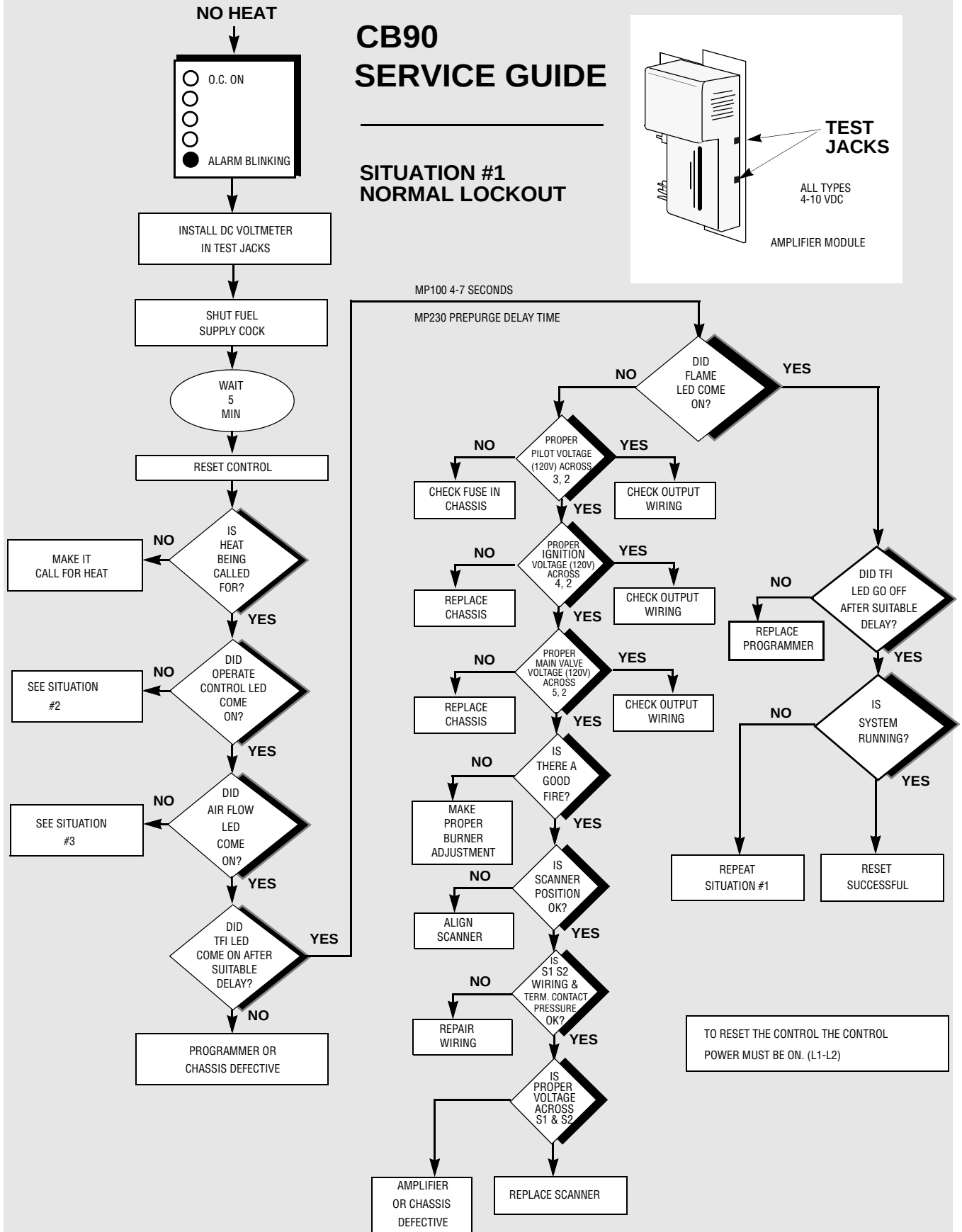
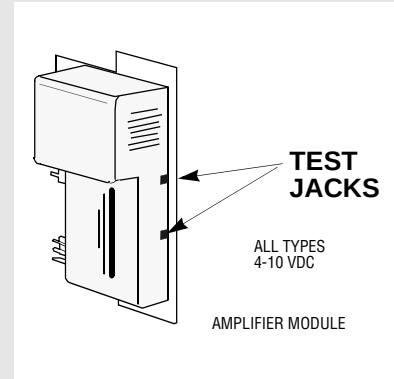
1. Temporarily connect spark ignition and pilot to Terminal #3.
2. Initiate a normal start-up.
3. Manually shut off all fuel and observe the loss of flame signal on the test meter.
4. If flame signal does not reduce to zero within the flame failure response time of the control (FFRT determined by the selection of the amplifier), verify the UV flame detector is not actuated by the ignition spark. If spark is detected, a metallic shield or relocation of the UV detector is required.

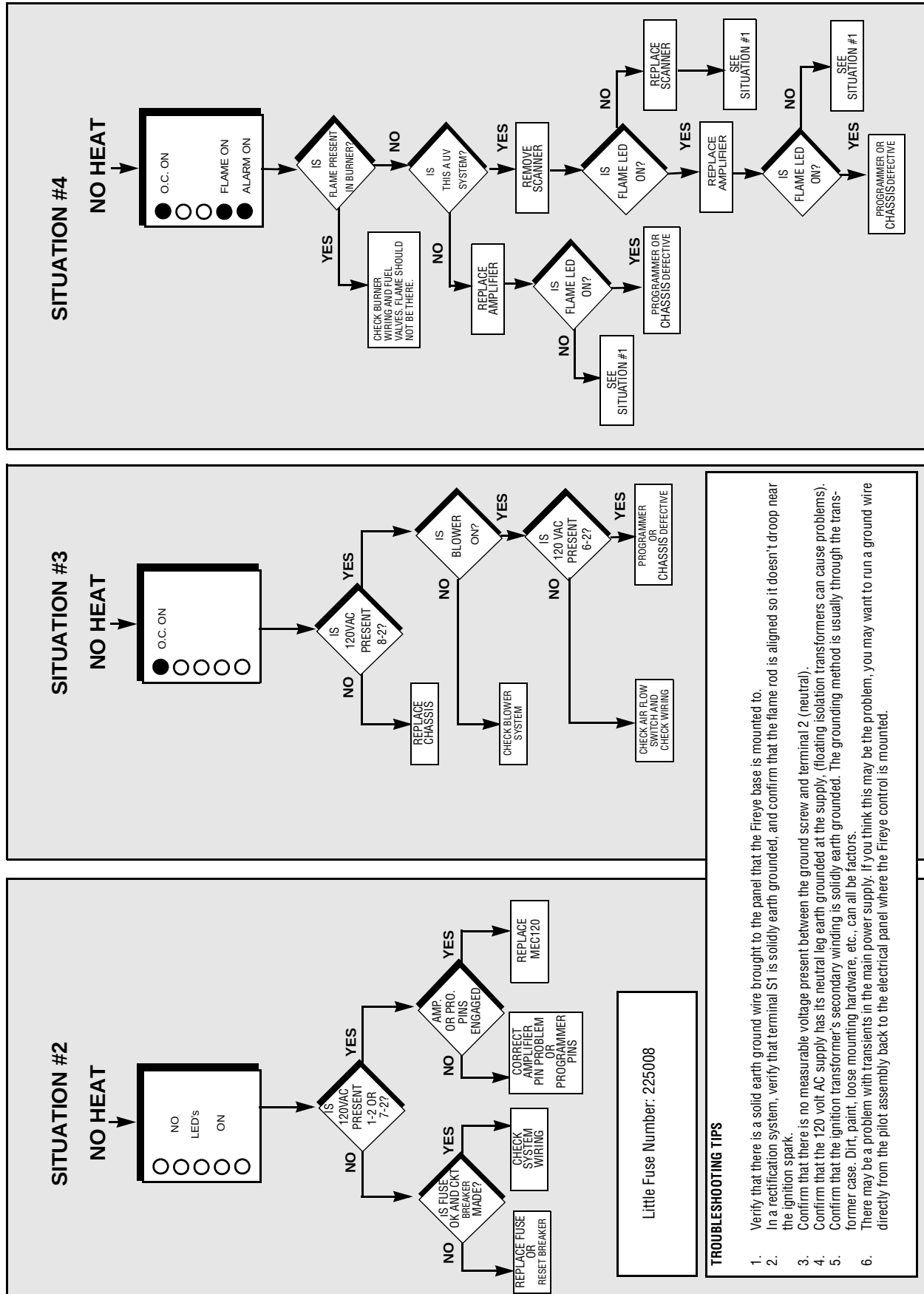


5. **IMPORTANT: When the test is completed, reconnect the spark ignition to Terminal #4.**

CB90 SERVICE GUIDE

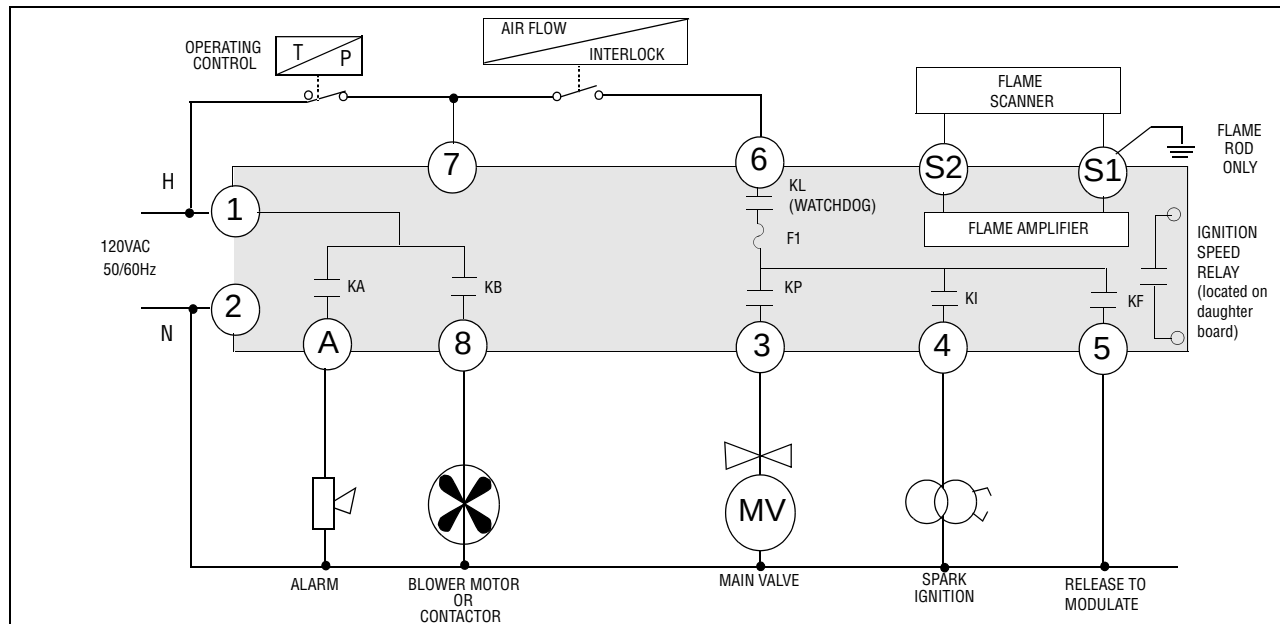
SITUATION #1 NORMAL LOCKOUT





Wiring Arrangements

FIGURE 4. WIRING ARRANGEMENT FOR SPARK IGNITED BURNERS USING 833-3163 or CB90 PROGRAMMERS.



SUGGESTED GROUNDING RULES

The CB90 system, being microprocessor based, requires a ground system that provides a zero-volt-age reference. The voltage measured from L2 to all other terminals except L1 should be 0 volts.

1. The most effective ground is to run the ground wire in the same raceway as the hot and neutral from the main distribution service panel (not intermediate sub-panels) to the burner control panel and insure that this ground wire is well bonded to the control panel.
2. The wiring base of the CB90 must have earth ground providing a connection between the sub-base and the control panel or the burner.
3. The earth ground wire must be capable of conducting the current to blow the 20A fuse in event of an internal short circuit. A number 14 AWG copper conductor is adequate, wide straps or brackets are preferred rather than lead wires.
4. The ground path needs to be low impedance (less than 1 ohm) to the equipment frame which in turn needs a low impedance to earth ground. For a ground path to be low impedance at RF frequencies, the connection must be made with minimum length conductors having maximum surface areas.
5. All connections should be free of nonconductive coatings and protected against rust.
6. Utilizing conduit as a means of providing a ground must be avoided.
7. Installing ground rods at the burner control panel defeats the purpose of a single point ground as described above and could also present a safety hazard.

INSTALLATION

Do not run high voltage ignition transformer wires in the same conduit with flame detection wiring. Do not run scanner wires in a conduit with line voltage circuits.

Ensure the frame of the ignition transformer is securely connected to control panel frame or preferably the burner frame.

The CB90 chassis contains a transient suppressing device connected internally across hot and neutral and then to the internal bracket. For this to be effective the chassis must be screwed securely into the wiring subbase.

REMOTE DISPLAY

When the 833-2714 is to be remotely mounted on the front of the control panel, the ED580 cable must contain a ferrite core. The cable end with the ferrite core must be mounted at the control end. High frequency currents flow more to the surface of the conductor. The 60 Hz ground system, properly designed, has sufficient low-impedance at 60 Hz to maintain all metal surfaces at the same ground reference. But, this same system is unable to provide this at higher frequencies, because of the increased impedance caused by the 'skin effect'. The purpose of the ferrite core is to provide a low-impedance at these higher frequencies and absorb this unwanted energy.

Care must be taken not to route the ED580 cable in close proximity to any starter motor contactors located in the control panel or across any high voltage ignition wires.

COMMUNICATIONS

When interfacing Cleaver Brooks controls to a communication system, be it a PLC or other micro-processor based device, ferrite cores should also be utilized. Proper twisted shielded pair cable must be utilized. In a multi-drop system, the shields should be tied together within a cabinet and not to any ground point. The shield at the source end of the cable of the multi-drop connection can then be terminated to ground. Source end is defined as the originating end of the communication system

Care must be taken not to route communication cables in close proximity to any starter motor contactors located in the control panel or across any high voltage ignition wires. Refer to Fireye bulletin E-8002 for proper installation.

SCANNERS

The armored cable supplied with the Ultra-Violet and Infrared scanners should be connected to equipment by means of a good mechanical connection such as a conduit fitting. It may be necessary to utilize heat insulator (P/N 35-69) to isolate the sensing end of the scanner from boiler ground. Care must be taken not to route the scanner cable across the high voltage ignition cable. The high energy ignition cable should be checked periodically for cracking, connections and aging.

In applications using flame rod units, it may be beneficial to route a separate return wire from the S1 terminal to the flame rod assembly. This will minimize the effects of transient currents flowing into the CB90.

In all cases, scanner wires should be routed in separate conduit and not joined with any high voltage AC or ignition cables.

MAINTENANCE

Periodically, the spark electrode should be inspected for proper gapping and cracked ceramics. At ignition time, the high energy from the ignition transformer will attempt to conduct to the point of least resistance and with an improper spark gap, where the conduction takes place will no longer be controlled.

The VA rating of the control transformer must be sized to handle the inrush currents of the pilot solenoid and ignition transformer at TFI and then the inrush currents of the main fuel valve assembly at MTFI time.

Inspect neatness of wiring in junction boxes and cabinets. It is best to have connections short and direct and also not having wires bunched up and tied off. Also, connections should be periodically Smoke or unburned combustion gases absorb ultraviolet energy. On installations with negative pressure combustion chambers, a small hole drilled in the UV1, UV2 sight pipe will assist in keeping the pipe clean and free from smoke. For positive pressure furnaces, provide clean air to pressurize the sight pipe, if necessary.

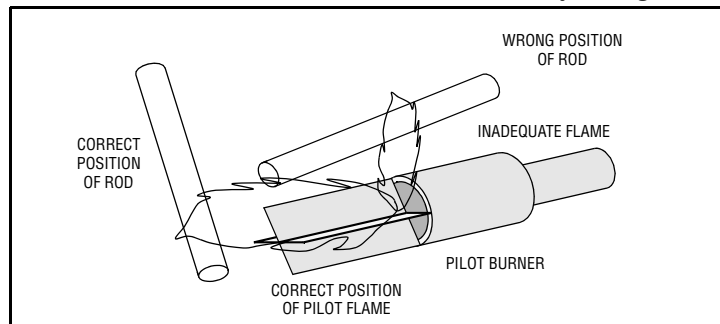
INSTALLATION - 69NDI FLAME ROD

The 69NDI flame rod proves a gas pilot flame and/or main gas flame. It is a spark plug type unit consisting of 1/2" NPT mount, a KANTHAL flame rod, a glazed porcelain insulating rod holder and a spark plug connector for making electrical connections. The 69ND1 is available in 12", 18" or 24" lengths.

The flame rod may be located to monitor only the gas pilot flame or both the gas pilot and main gas flames. It is mounted on a 1/2" NPT coupling.

The following instructions should be observed:

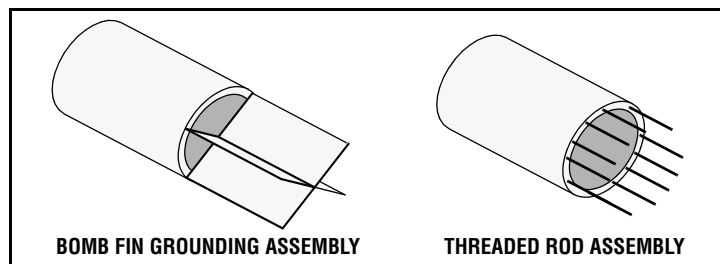
1. Keep flame rod as short as possible.
2. Keep flame rod at least 1/2" from any refractory.
3. Flame rod should enter the pilot flame from the side so as to safely prove an adequate pilot flame under all draft conditions.
4. If the flame is nonluminous (air and gas mixed before burning), the electrode tip should extend at least 1/2" into the flame, but not more than halfway through.



5. If the flame is partly luminous, the electrode tip should extend only to the edge of the flame. It is not necessary to maintain absolutely uninterrupted contact with the flame.
6. It is preferable to angle the rod downward to minimize the effect of sagging and to prevent it from coming in contact with any object.
7. An adequate grounding surface for the flame must be provided. The grounding surface in actual contact with the flame must be at least four times greater than the area of the portion of the flame rod in contact with the flame. It is essential to adjust the flame rod and ground area ratio to provide a maximum signal reading.

NOTE: Interference from the ignition spark can alter the true signal reading by adding to, or subtracting from it. This trend sometimes may be reversed by interchanging the primary wires (line voltage) to the ignition transformer. This interference can also be reduced by the addition of grounded shielding between the flame rod and ignition spark.

8. Proven types of flame grounding adapters, as shown below, may be used to provide adequate grounding surface. High temperature stainless steel should be used to minimize the effect of metal oxidation. This assembly may be welded directly over the pilot or main burner nozzle.



MAINTENANCE

Type 69ND1 Flame Rod

The flame rod and its insulator should be kept clean by washing routinely with soap and water. Rods should be routinely replaced as they oxidize.

Flame Signal Strength

Routine observation of the flame signal strength will forewarn any deterioration in the capability of the flame detector or its application.

Contacts

There are no accessible contacts in the CB90. Where contacts are used, their design assures long trouble-free life when the load circuits are maintained within the published load ratings.

Humidity

In areas of high humidity, the control chassis should be removed and placed in a dry atmosphere when the system is expected to be out of service for an extended period.

Periodic Safety Check

It is recommended that a procedure be established to test the complete flame safeguard system at least once a month. This test should verify the proper operation of all limit switches and safety interlocks as well as flame failure protection and fuel safety shutoff valve tightness.

Rotation

It is recommended that control and scanner units purchased as spares be installed periodically to ensure proper operation.

